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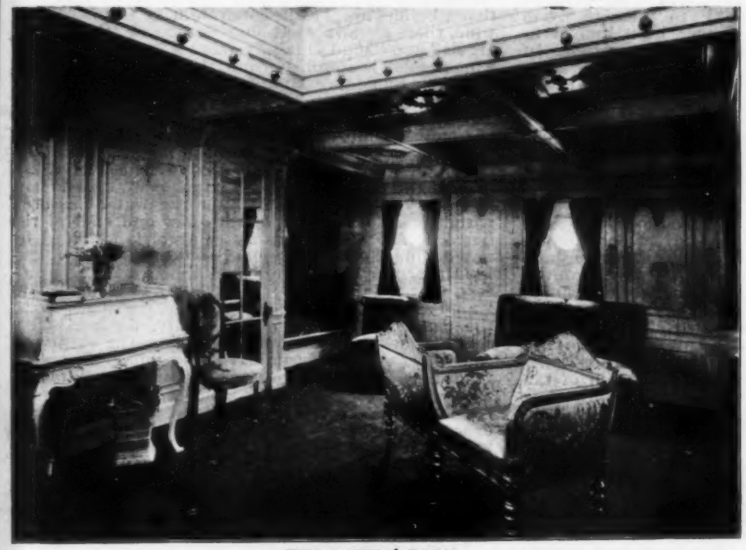
THE STEAM YACHT "JOSEPHINE."

We present herewith a series of views of the recently completed yacht "Josephine," which has been built for Mr. P. A. B. Widener, of Philadelphia, by the Neafie & Levy Ship and Engine Building Company, of that city.

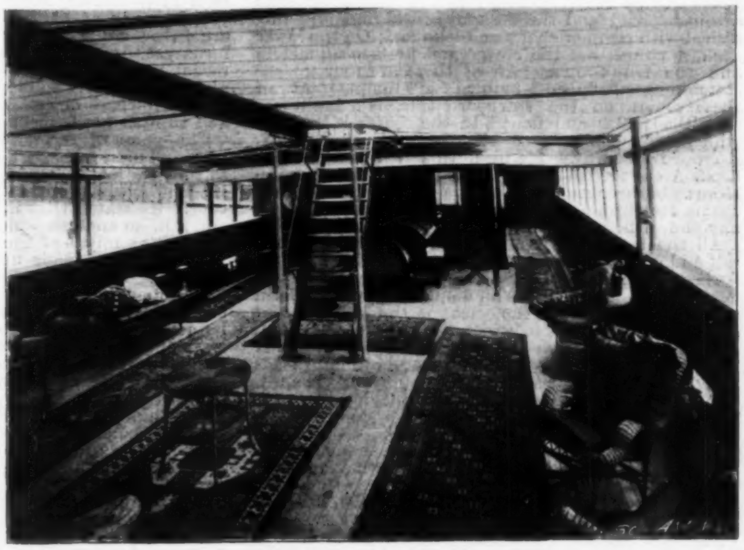
The "Josephine" is a schooner-rigged yacht with two pole masts. She has an over all length of 258 feet, and a handsome sheer, and is 216 feet on the water line. She has a molded beam of 30 feet and 3 inches, and the depth to the main deck is 18 feet and 6 inches, and to the awning deck 26 feet and 6 inches. In the construction of her hull the full requirements of the British Lloyds to class 100 A1 have been fulfilled and even exceeded. Particular attention has been given to strength, special features being introduced with that end in view. The vessel has a cast steel stem and stern, thoroughly secured to the hull; the plating is flush above the water line, and it is carried to the awning deck, with the result that she has a high freeboard the greater part of her length. The latter deck is carried forward to the stem, which is finished in a handsomely carved figurehead. There is a cellular bottom extending between collision bulkheads, and transverse bulkheads divide the hull into numerous water-tight compartments.

THE DINING ROOM.

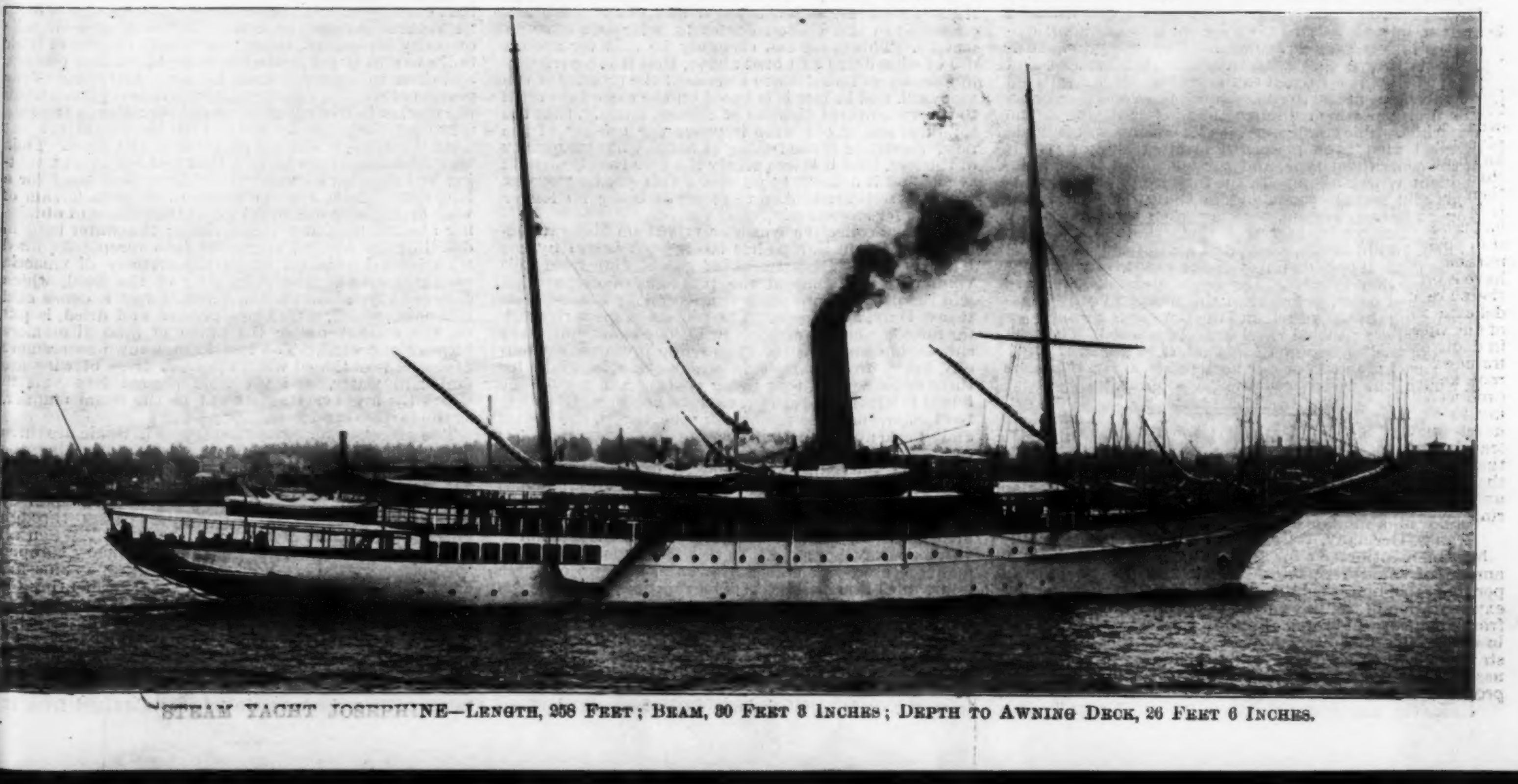
On the awning deck, which extends from the stern aft for three-quarters of the length, is erected a steel house, 11 feet in width by 68 feet long, the outside of which is paneled in teak, the steel work being fully covered. In the forward end of the house is the chart-room, which measures 10 feet by 14 feet and is handsomely finished in antique oak with a massive chart table and upholstered seats. It is lighted by plate glass windows of a very beautiful design. Aft of the chart-room is the captain's room, finished in antique oak, with the usual berth and desk; and behind this is the library, finished in black walnut with richly carved walnut panels. The room is fitted with bookcases, upholstered seats, and a large, open fireplace. At the after end of the library an open stairway finished in black walnut leads to the reception-room. Forward on the main deck below are the crew's washroom, windlass for hoisting the anchor, and aft of these is the wardroom or dining-room of the officers, waiters, etc., with staterooms and baths for the same on the sides, the whole being finished in yellow pine. Aft of the wardroom are the two owners' rooms, each of which



THE LADIES' ROOM.



THE MAIN DECK, AFT.



STEAM YACHT JOSEPHINE—Length, 258 Feet; Beam, 30 Feet 3 Inches; Depth to Awning Deck, 26 Feet 6 Inches.

measures 12 feet by 17 feet. They are finished in birch with rich paneling and carving. There is a drop of 30 inches in the awning deck at the forward end of the owners' rooms for the placing of large forward air ports by opening which a thorough ventilation of the rooms may be secured. These two rooms, which are abreast of each other, are admirably lighted through these ports and by the large circular lights in the sides of the vessel. The rooms are furnished with desks, chiffoniers, wardrobes, massive brass bedsteads and every convenience known to the ship decorators' and furnishers' art. Each room has its own bathroom, thoroughly equipped and tiled in a light and artistic pattern.

The owner's room opens aft into a hall, from which stairways lead to the chart-room above and to the guests' staterooms below. Aft from this hall on the port side and abreast of the boiler inclosure is the main gallery and pantry, and on the starboard side are the engineers', doctors', valets', and chief stewards' staterooms—all finished in oak of natural finish. The passageway between these rooms and the boiler inclosure, leading aft from the owner's rooms to the main dining-room, is richly paneled in oak, finished Louis XV. style.

Immediately aft of the boiler inclosure is the main dining-room, which is, perhaps, the most handsome room in the whole ship. It extends the full width of the vessel, or 30 feet, and it is 16 feet in width. The whole room is paneled in oak, in the style of the Italian Renaissance. In the forward side of the room there is a large open fireplace, with bric-a-brac mantel of oak, richly carved, and on the opposite side is a large panel containing the handsome tapestry which will be noticed in our engraving of this room. At each end of the dining-room are sideboards, and, in addition to the porthole windows on each side, the room is lighted by two skylights, one on each side of the deck house above. The visitor is struck by the extreme beauty of the oak carving in the panels of the ceiling, and, taken altogether, in point of treatment, this is one of the most successful dining-rooms that we remember ever to have seen on a yacht. Aft of the dining-room and abreast of the engine inclosure on the starboard side is the reception room, which is finished in black walnut in Louis XV. style; and aft of the engine inclosure is the ladies' room, of which we present an engraving, which is finished in cream white enamel on cherry, and exquisitely paneled and carved. In the aft end of this room is a stairway leading to the staterooms below. From the ladies' room aft, the main deck is open and is covered with an awning. One of our engravings is taken at the extreme after end of the vessel on this deck, looking forward, and shows the awning spread and the deck laid with rugs and furnished with steamer chairs and lounges. On the lower deck, forward, are the crews' and firemen's quarters and the trunk-room. Aft of these are four guests' staterooms, all finished in bird's eye maple. Aft of these rooms, on the starboard side, is a bathroom with tiled sides and floor. In the center is the hall, which is finished in Louis XV. style and oak paneled. An open stairway leads from this hall to the main deck. Aft of the machinery spaces are the family staterooms, bathrooms and dressing-rooms. The bathrooms are tiled, and the rooms are finished in mahogany and white and gold.

All the bathrooms are supplied with hot and cold, salt and fresh water from pressure tanks, which are fed by large pumps in the engine-room. The water system is automatic and furnishes an ample supply at uniform pressure. A feature in the yacht is the incandescent lighting for decoration, which includes a horizontal belt and a cable of lights which reaches from the water up to the end of bowsprit, thence over both mastheads and down to the water again at the taffrail. There is also a set piece between the masts displaying the name "Josephine" in electric lights. The system includes altogether 900 lights.

The propelling machinery consists of one inverted direct-acting quadruple expansion engine, having cylinders of 19½, 28, 39, and 57 inches diameter, with a common stroke of 36 inches. Particular attention has been paid to the counterbalancing of the engine, with the result that vibration has been practically eliminated. Steam is supplied by two cylindrical return tube boilers and at a pressure of 200 pounds to the square inch. The boilers are fitted with an outside draught system, in which two fans 66 inches in diameter discharge into the smoke tank. Cold air from the ventilators is drawn through heaters in the uptakes, and from this point is carried to the grates. It is regulated by valves set in the fronts. There is an ash ejector in the fireroom which discharges overboard above the waterline. The condenser is independent and is made of steel with tube plates. The circulating pump is of the centrifugal type, and the air pump is an independent Worthington. In the forward hold is a capacious cold storage room, and in the after hold is the storage battery system, together with the fresh water tanks. The yacht carries a steam launch, naphtha launch, two lifeboats, a gig, and a dandy.

The general outside finish of the yacht is in keeping with the rich interior. Handrails, stairrails, etc., are of polished brass, as are even the bitts and other massive fittings of the vessel, and the bulwarks throughout the vessel are paneled in selected dark wood. The trial speed of the "Josephine" was about 18 knots.

We are indebted for our particulars to Mr. Sommers J. Smith, the designer of the "Josephine."

ARGOLS.

By R. Hedger Wallace.

Argol is a good illustration of what constitutes an agricultural by-product, it being a substance usually found in abundance in the viticultural districts of France, Germany, Italy, and Spain. Argol is simply the mercantile term for crude tartar, and is a by-product of vinous fermentation. It exists in the juice of the grape, and is soluble therein; but during the fermentation of the juice as it passes into wine, alcohol is developed, which, remaining in the fermenting liquor, causes the precipitation of the argol. Some wines, if bottled when not fully ripe, develop more alcohol on keeping, and a further precipitation of argol therefore takes place, recognizable as a crust in the bottom; hence the meaning of the term "crusted port." This substance forms a crystalline deposit or crust on the inside—bottom and sides—of wooden casks, vats, or tubs in which vinous fermentation takes place. It is, however, only deposited during such fermentation, never afterward. When the wine is drawn off, this deposit is scraped from the inside, and the crust becomes hard, brilliant, and brittle, and is readily reduced to powder. The crystals are white or slightly colored, according to the character of the wine in which they are deposited. That which is found in barrels having contained white wine is of a dark cream color, while that extracted from red wine barrels has a pinkish tinge.

The argol deposited by white wine contains fewer impurities than the other, but when refined both are identical. The quantity found also varies according to the quality of the wine. The white wine gives less than the red, the strong more than the light wine. Locality, apparently, also affects production. It is said that the meridional provinces in Italy yield more argols than any other part of that country; and wine growers in the Pfalz, the area lying west of the river Rhine, state that wine made from grapes grown upon the northern slopes of the ridges and hills yields more argol than wine made from the fruit grown on the southern or sunny slopes. In France, the wines producing the largest quantities of argol are those of the extreme south, and the trade in it is consequently limited almost entirely to the regions about Marseilles, Bordeaux, and Lyons.

It is well known that, in many instances, it becomes necessary for the viticulturist or wine merchant to clarify the product of the vineyard by treating it either with gypsum or the white of eggs. Wine clarified by gypsum is richer in argol than that which it has not been found necessary to treat in this manner, while clarets cleared by the albumen of eggs are said to produce an argol which yields an exceptionally superior quality of cream of tartar. The most important argol-producing localities in Europe, let us add, are the districts adjacent to Messina, Naples, Palermo, Bordeaux, Lyons, Marseilles, Lisbon, Barcelona, and Tarragona, all of which are viticultural centers.

Though we recognize argol, or crude tartar, to be a collateral product of wine, yet the fact that it is formed only by wine which has reposed in wooden casks proves it to be a product as recent in origin as are wine casks themselves. Ancient Greeks and Romans knew not the value of casks, for they kept the fermented juice of their grapes in great earthen vessels, very much like those employed to-day in certain parts of Spain. Any one who has traveled in the Iberian peninsula will recall the fact that wine there is often kept in goatskins, stone cisterns, and other strange vessels made of hides and clay. In these receivers argols, or crude tartar, have never been known to form, yet the wines of Spain are rich in the article. In recent years, however, the Castilian viticulturist has almost exclusively employed for storage wooden casks, for the purpose of collecting this valuable sediment, and adjunct to the income from wine making.

The value of tartar as a medicine is said to have been first discovered by Paracelsus, the celebrated Swiss astrologer, alchemist, and professor of medicine at Basle, who was born at the end of the fifteenth century. He stated that it was composed of oil, water, and salt, an analysis which is as inaccurate as the same scientist's analysis of the human body, which, according to him, was made up principally of sulphur and mercury. The real composition of argol was, however, determined in 1770 by the celebrated Pomeranian chemist, Scheele, the discoverer of chlorine, who found its active principles to be composed chiefly of bitartrate of potash along with a small portion of tartrate of lime. Argol, then, may be regarded as crude potassium bitartrate, and from it is produced cream of tartar, tartaric acid, tartar emetic, potassium carbonate, black flux, pearl ash, baking powders, and mordants for fixing colors in dyeing.

An ordinary French wine barrel yields from one to two pounds of argol, or wine lees, which the viticulturist sells to the tartar manufacturer, who either disposes of it in its crude form or refines it into cream of tartar. In some instances, however, these wine dregs, instead of being used in the manufacture of cream of tartar, are employed by brandy merchants to impart a fruity flavor to newly distilled spirits, very much in the same manner as burnt sugar and prune juice are employed in the United States to color and sweeten whisky. This much can certainly be said for such a use of wine dregs as noted above, that it is a perfectly innocuous and wholesome essence of the product of the vineyard, and in fact it is based on the theory common to the viticultural districts of France, namely, that the solidified lees of old wine improve the quality of the new. So strong is the feeling as to the valuable quality of the lees, that it is frequently the case that dealers in argols find it difficult to purchase this product except where barrels are broken to pieces as being no longer suitable for storage purposes.

A special collective consular report on the production of argols in Europe has lately been issued by the United States Department of State, and from this volume we note some of the processes of preparation and the preparations made from argol in France, Germany, Italy, and Spain. The process of preparing tartar for commercial purposes in France is not only very simple, but inexpensive. The crude product is generally taken from barrels in which wine has lain for three or four years, that being the average period the liquid is left in the cask previous to bottling. Of course the longer the wine remains in the barrel, the better and more abundant will be the lees. About 30 per cent. of these settlings is crude tartar. The wine being drawn off, the sediment is removed in a crust, usually detaching itself in irregular cakes of about four inches square in extent, and half an inch in thickness. These cakes are allowed to dry, after which they are triturated, either by hand or machinery, until they resemble very fine gravel or sand. In this form it is sold to the manufacturer, who boils it in water for two or three hours until it is dissolved. The solution thus made is then drawn off into shallow metal or earthenware receivers, upon the bottom and sides of which the tartar forms as it cools a mass of crystals. The liquid that remains is boiled and cooled over and over again, until evaporation is complete, and nothing but crystals are left. Purified tartar becomes cream of tartar, or bitartrate of potash, forming a white odorless crystal of an acrid taste. There are two varieties of cream of tartar made in France, the crême de tartre de Montpellier, sold in irregular cake-like crusts, and the crême de tartre de Marseille, in smaller cakes. The Montpellier tartar is made by boiling crude tartar in water with animal charcoal and clay; these substances form a white scum, which is taken off and allowed to crystallize, the crystals being subsequently washed in cold water and dried. The pure tartaric acid is then isolated from its acid potash by what is known as "Scheele's process." The processes by which various tartrates and other combinations of tartar are derived from argols are technical and chemical, and much too intricate to be mentioned here.

Argol was extensively used in former years by dyers as a mordant, that is to say, as an intermediate substance, which having a strong affinity for both organic fibers and coloring matter, becomes a bond of union between the two, making thereby a fast color. The reactions or combinations formed, when used as a mordant, were tartrate of alumina and tartrate of tin. In Germany, argol in former years was much used when woolen goods were dyed, but since the introduction of aniline colors it has lost its value as an article of commerce in this industry. Still, however, the principal market for argols from white moselle is the chemical and cloth factories of Germany, and quite a quantity of tartaric acid is converted into dioxy-tartaric acid, and used in the manufacture of a yellow coloring matter for wool, known as tartrazine. The chief countries which import argol or tartar are England and the United States, but the shipments to the latter country are exceptionally large, it taking more than double the quantity shipped to all the other countries combined, owing to the fact that it is there used on a very large scale in the manufacture of baking powder, a purpose for which it is not so universally employed elsewhere. The extent to which tartar is used in combination with food products would, it is stated, be perhaps "most easily ascertained from the export books of the numerous baking powder firms of the United States, unless the relative prevalence of dyspepsia in various countries should be deemed a sufficient answer." Such an inquiry, however, does not come within the scope of this article.

Before proceeding to note some interesting facts regarding the production of argols in Germany, Italy, and Spain, we would state that in some countries only the crust of crude tartar attached to the sides of the cask is termed argol, while the sediment adhering to the bottom is designated lees. In this article, however, we use the term argol to include any natural product obtained in the process of wine making which contains tartar. Turning to Germany, we find that there, besides argol (called weinstein in German) from wine, there are also what may be termed "husk wine argols" and "mud argols." What is known as "husk wine argols" is obtained from the skins and pulp of the grape remaining after the husk brandy has been extracted, and is produced in the following manner: The husks, etc., which are found in the boiling vats are emptied into a wine press, and all the liquid remaining is pressed out. This is again boiled and drawn off into barrels and cooled with ice water. In from eight to ten days the argol contained in the liquid crystallizes out, and after the water has been withdrawn it is taken from the sides and ends of the barrels. An inferior quality of argol is obtained by not boiling the liquid pressed out, and simply allowing the argols, by what may be termed a natural process, to precipitate out. This is what is known as "mud argols." Some distillers, after having pressed the grapes and secured the brandy, do not boil a second time, as noted above, but allow the extract to run direct into casks or barrels in which birchwood twigs have been placed, and to these, on precipitation, the argols adhere. In casks made of chestnut wood it is said no argol (wine stone) will be formed. In whatever way the crude argol be obtained, it is disposed of to the "Weinsteinfabriken," where it is converted into various preparations of tartaric acid, such as cream of tartar, seignette salt, tartar emetic, potassium carbonate, black flux, and pearl ash. The by-products of the Weinsteinfabriken are disposed of to manufacturers of fertilizing materials.

As was to be expected, a large quantity of argol is produced in Italy. The collections from vats, etc., in that country are taken to local markets and sold to "tartarari" or tartar men. When a considerable quantity is received, these "tartarari" dispose of their bulks to still larger dealers in more important centers, and these to large wholesale houses. According to the process of making employed, the article is placed upon the market in five varieties, as follows: Feccia asciwtta (dry lees), the name for the lees left behind in the vat after the wine is drawn off for the first time. Then tartaro crudo (crude tartar), that is the sediment coating the interior of vats which have been used for a long time. Next comes cremore di vinaccia (cream of wine dregs), and it is obtained in the process of obtaining alcohol from the grape skins; the water used in distilling the alcohol is poured into receptacles filled with birch-broom, on which the cremore di vinaccia crystallizes out. The remainder of the fluid, which does not crystallize on the birch, forms a dense acid sediment, which, after being pressed and dried, is put on the market under the name of limo di cremore (deposit of cream). The last form, known as cremore di seccia, is obtained when the fresh dregs of wine are boiled in water, and the fluid poured into vats in which the argol crystallizes out in the usual manner, as the tartaro crudo.

The processes for extracting argols in Spain are three in number, and are very simple. In making wine, the grapes are gathered in large baskets and placed in a vat, which is generally located in a specially constructed outhouse. They are here trodden upon by barefooted peasants, and the juice passes through holes in the bottom of the vat into a tank. When all the juice has been extracted, it is customary to open the bottom of the vat, and to let the grape skins fall down into the juice, and remain there fermenting for six or eight days, in order that the wine may become more highly colored. At the end of the fermenting period the juice is drawn off and put in barrels, and the grape skins are put into presses, which extract the juice that remains, and this is also put into the same kind of barrels. What remains in the presses are then taken to factories, where alcohol is obtained from it.

After this process is concluded vine shoots are placed in the hot liquid residue left, and as the liquid cools, argol gathers about the shoots, from which it is, in due course, scraped. It is then dried and whitened by various methods, all of which are considered secret. The argol so produced by this process is, however, of the lowest quality, and is the least valuable.

The juice that was taken from the vat and put in barrels is generally kept from fifteen to twenty days, when it is carefully taken out and the lees are sold to wine brokers, who at once extract what wine still remains and then dry the rest and sell it to the tartar factories, in which it is prepared for the market. This kind of argol is ranked as tartar of the second class.

The best tartar is obtained from wine that is withdrawn from the vat and kept in one set of barrels for five years or more, and in the inside of which it crystallizes out. When this is finally taken out, it is dried and sold to the factories. The drier the nature of the wine, the more argol it produces. The principal market for tartar in Spain is Barcelona, and there is apparently a large home demand, it being principally used as a diuretic, refrigerant laxative, and cathartic, and in bread-making.

What has been said as to extracting argols from wine applies also to the extracting of argols from pomace or crushed apples, and it is often so extracted in districts where cider is made. The production of argol or tartar, it must be borne in mind, does not constitute an actual industry in itself, but is only an accessory to wine and cider making, and may be therefore regarded as a supplementary agricultural industry. Further, it is apparent that the only process for extracting it is a natural one, and it is so simple that it can be undertaken by anyone. Next to the United States, England is the heaviest importer of crude tartar. As we have no vineyards, with one solitary experimental exception, in this country, the production of argols should be taken up by our wine-producing colonies. It is not a high-priced product, but it is a source of profit, as all waste products are when utilized.—Journal of the Society of Arts.

THE ELECTRICAL MANIPULATION OF THEATRICAL MACHINERY.

JUDGED by Continental standards, the English-speaking peoples are, in the applications of electricity to stage mechanism, very much behind the times, but the recent installation at the Drury Lane Theater, London, under the direction of Mr. E. O. Sachs, will undoubtedly prove an important stepping stone to the general use of electricity for this purpose. On the Continent, for a long time, hydraulic mechanism has been used to manipulate the traps and bridges, which are, after all, the most unwieldy part of the stage mechanism. The wonderful opera house at Vienna has, without a doubt, the finest installation of stage apparatus in the world, and Mr. Sachs has already described the mechanism in an exhaustive monograph on the opera houses of Europe. It may be said in passing that the Drury Lane Theater is the home of melodrama, so that it is essential to produce effects and many changes at the smallest possible expenditure of time. In the remodeling of the Drury Lane stage the idea was to make the whole central part of the stage movable. As will be seen by our diagram, two sections or "bridges" have now been completed. They are each 38 feet and 10 inches long by 5 feet 6 inches wide. They are well braced together, as shown in our engraving, and form a rigid structure on the top of which is the flooring, forming part of the stage. This floor is 40 feet long by 8 feet wide. The steel portion of each lift weighs a little over 4¾ tons and the platform about 1½ tons more, so that the total weight is not far from 6 tons. About two-thirds of this weight is taken off from the hoisting apparatus by counterweights. The bridges are calculated to travel from 8½ feet below the stage to 10½ feet above the stage. In order to prevent the bridges from binding they are provided with long legs which slide in angle guides attached to steel stanchions. The mechanism which operates the lifts is placed entirely below them in order to allow an uninterrupted floor when the top of the lifts are flush with the stage. Each lift has an independent set of motors to work it. Each motor is of 7½ horse power and is of a four-pole inclosed type, the motor being shunt-wound. The motors make 520 revolutions a minute The speed is regulated in a ratio of 104 to 1 through a large worm and worm wheel, the worm wheel being geared to a shaft which carries two winding drums which make five revolutions per minute. Upon these drums are wound steel wire ropes which pass over guide poles and are connected at four places on the legs of the lift near each corner. The speed of lifting corresponding to the full speed of the motor is 16 feet per minute, but this can be reduced to 6 feet per minute, if desired. Equalizing devices are provided so that the tension on the ropes is rendered uniform. The movement of the lift is controlled by a combined starting and reversing switch which is operated below the level of the stage from a position by which the operation of the machinery can be observed. Hand gear is provided for working each lift in case the electric power should fail. The stage devices are fitted for holding the lifts stationary in case the rope should break, as very often as many as thirty people would have to be carried on them. Automatic switches are provided for cutting off the current in case the operator should be derelict in his duty. Appliances are also provided for stopping the bridges at a certain fixed place. The lifts have been tested thoroughly and they have worked with smoothness and without jarring. The new installation may be regarded as a most important advance in stage mechanism.

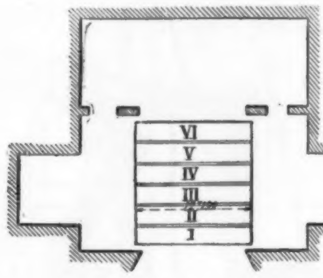


FIG. 1.—PLAN OF STAGE.

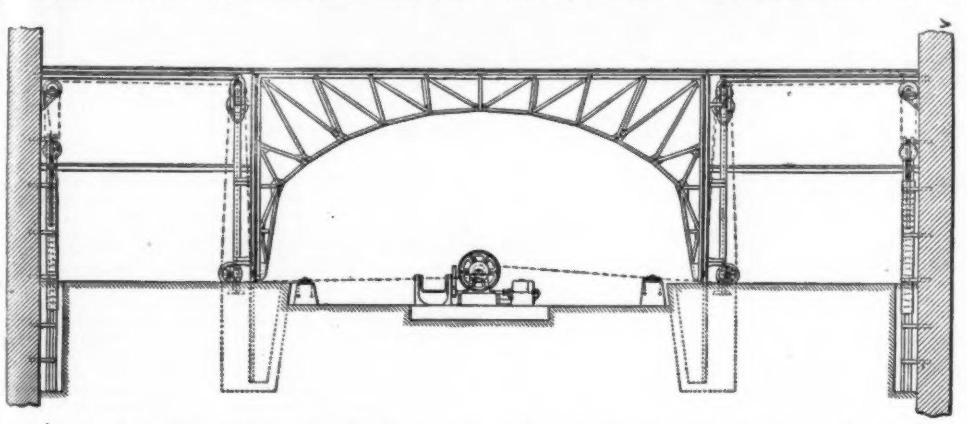


FIG. 2.—ELECTRIC MECHANISM OF "BRIDGE," DRURY LANE THEATER, LONDON.

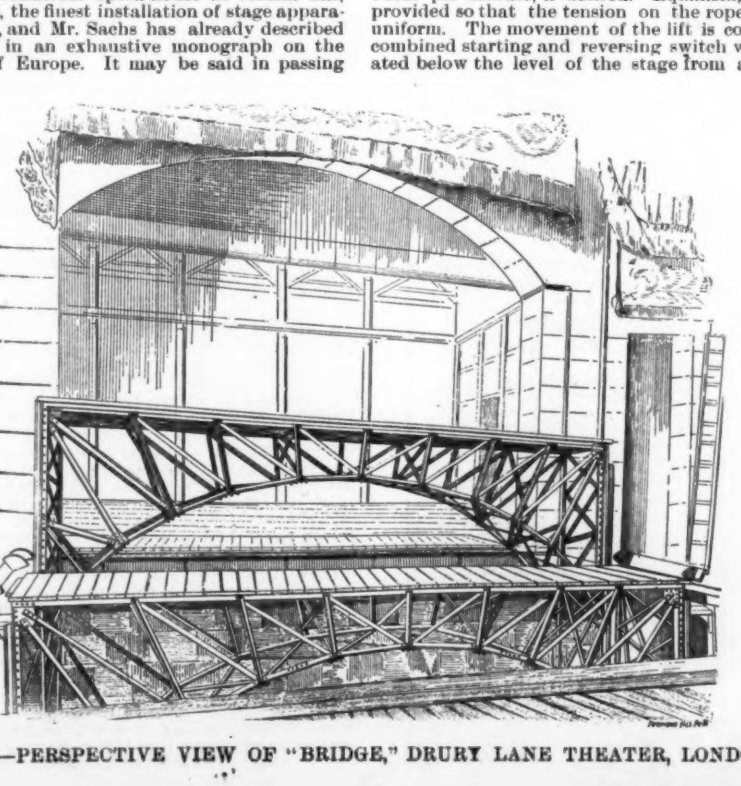


FIG. 3.—PERSPECTIVE VIEW OF "BRIDGE," DRURY LANE THEATER, LONDON.

IRON AND STEEL INDUSTRIES IN GREAT BRITAIN IN 1899.

OWING to the very exceptional pressure that has been put on ironmakers during the present year, there has been a general idea that the make of iron must have been much larger than usual, and larger than would merely be represented by the additional number of furnaces in blast compared with the first six months of last year. On the other hand, owing to the comparative difficulty in procuring adequate supplies of iron ore and fuel, it has seemed to be probable that the blast furnaces have not been worked so regularly or to the same extent of their capacity as the demands of buyers would have rendered otherwise expedient. Indeed, some writers on the subject have gone the length of conjecturing that the increase of demand has not, for that and other reasons, been met by a corresponding increase of supply. All doubts on the subject have now been set at rest by the official statistics collected and published by the British Iron Trade Association, which show that the total make of pig iron in Great Britain for the first six months of 1899 has amounted to 4,782,868 tons, against 4,432,893 tons for the corresponding six months of 1898. This is an increase at the rate of about 700,000 tons a year, and if it is maintained, as it is pretty certain to be during the second half of the year, will make the output of 1899 over 9,500,000 tons, which is, of course, a record. Indeed, in no previous year has the pig iron output come up to 9,000,000 tons, so that the year 1899 will apparently not only signalize the largest production of pig iron on record, but it will also be notable for one of the largest advances in the history of the trade.

It will be remembered that the production of South Wales was last year seriously affected by the strike of miners, which made it practically impossible to procure local supplies of fuel. It is not, therefore, surprising to find that the largest amount of increase has taken place in that district, where the total make for the first six months of 1899 has been 467,960 tons, against only 245,085 tons in the corresponding six months of 1898. In several of the other districts, however, there has been a reduced production of iron, and as that has taken place in the face of an almost unprecedented demand and of an advance of nearly 50 per cent. in prices, it may be assumed that in the districts where this has happened influences were at work which prevented the ironmakers from producing so much as they would otherwise have done. These districts include Cleveland, Lancashire, and Northamptonshire, but in none of them, except Lancashire, has the reduction been very material. The imports of iron ore from Spain and other countries have been the largest on record, and exceed by about 600,000 tons those of any corresponding six months in the history of the trade. This is regarded as a good augury for the future, and the fact should go far to relieve the apprehensions that were generally entertained, and are in some quarters still felt, lest a scarcity of ores may compel a restriction of pig iron output on a considerable scale. And this satisfaction is emphasized by the knowledge that new sources of supply are every now and again coming into view, one of the latest being a large deposit in Algeria, while several comparatively new fields are being tapped in Spain. Moreover, the home deposits of ore are being proved to be more abundant than was anticipated, several new sources of supply having been opened out in West Cumberland, Northamptonshire, and elsewhere. Finally, there is the iron ore field which has recently been proved in Kent, and whence it is probable supplies will ultimately be drawn. About twenty-five more furnaces have been in blast during 1899 than were worked in the previous year, and twenty-five more are being rebuilt, or new furnaces in course of construction, so that there is every prospect of a further increase of output if raw materials are sufficiently cheap and abundant.

Stocks of pig iron all over the country are, however, exceptionally low. At the end of June there were 688,190 tons in public stores, and about 250,000 tons additional in the hands of makers. This is less than six weeks' make, so that the iron in reserve is not overabundant. There is not the same pressure of demand that there was a few months ago. Makers appear to have plenty of orders on hand, and the Continental demand is still very strong. Nevertheless, stocks in some cases are increasing, and especially on the west coast. If, therefore, there was at any time a danger of a pig iron famine, which the best informed authorities do not admit, that possibility is daily becoming more remote. Much will, however, depend on the iron trade situation in the United States. Should the Americans make large demands upon British blast furnaces, which is regarded as possible, prices may still run up to a figure that would lead to difficulty.

The statistics of the steel industry show that in the first six months of the present year the production of steel was:

	Acid (tons).	Basic (tons).	Total (tons).
Open hearth...	1,443,398	137,291	1,581,319
Bessemer	748,919	257,003	1,005,922
Total......	2,192,317	394,924	2,587,241

Here, again, there is a record output, taking the two descriptions of steel together. The make of open-hearth steel has exceeded by 276,000 tons the make of the corresponding six months of 1898, which was the next largest make in the history of the British steel trade, or, indeed, of the open-hearth steel trade of any country. The make of basic steel is also a record. The largest advance has taken place in Scotland, where the output of open-hearth steel in the first six months of 1899 was 517,107 tons, against 392,350 tons in the first

six months of 1898. In all districts alike there has been an increased output in 1899. The make of this description is now at the rate of over 3,000,000 tons per annum, and there is every likelihood that the total make of both descriptions for the year 1899 will considerably exceed 5,000,000 tons. This large increase has been mainly due to the enormous requirements of the ship-building trade, the ascertained make of steel ship plates for the first six months of the year 1899 having been over 700,000 tons, or at the rate of 1,400,000 tons a year. In many cases provision is being made for adding to the many sources of production. This, however, is to a considerable extent being done, not so much by an absolute increase of furnaces as by increasing the dimensions of the newer plant, and thereby securing a much larger output for a given number of furnaces. In other words, 40 and 50 ton furnaces are now to a large extent taking the places of furnaces of much smaller capacity. The total number of furnaces now available for smelting steel by the open-hearth process is about 400, and a number of new furnaces are being erected.

The statistics of both the open-hearth and the Bessemer steel industry for 1899 show quite clearly that there has been no real scarcity of pig iron. Otherwise the steel output could not have advanced as it has done. At the same time, the increased cost of pig iron and of fuel have, to a large extent, upset the calculations of steel manufacturers, many of whom found themselves with low-priced contracts on hand, which they were, in some cases where they had not fully covered their pig supplies, obliged to work off at a loss. Most of these old contracts, however, have now been got rid of, and, at present prices, it is probable that steel makers are doing as well as they have ever done. The outlook of the trade is regarded as exceedingly favorable, and there are not a few who believe that it will become even more so, but this, again, will largely depend on what our American friends may do in the way of placing contracts on this side of the Atlantic. —The Economist.

THE WORKS OF THE DIAMOND MATCH COMPANY, LIMITED.

THE works of the Diamond Match Company, Limited, are situated off the Linacre Road, at Seaforth, some four miles from Liverpool and about three-quarters of a mile from the Seaforth Station of the Lancashire and Yorkshire Railway. The building is a substantial brick structure, having the form of a letter E at the basement level, which is somewhat modified as the building gets higher. The utmost care is taken to provide good light and ventilation, as will be explained hereafter, and also every possible precaution is taken to prevent the spread of fire. The land owned by the company is said to be seven acres in extent, and the buildings at present cover some one and a half acres of this, which leaves a considerable space for extension, though part of the land is at present used for storing the logs of wood from which the strips used in the manufacture of boxes are cut.

The motive power for the machinery of the factory and for the lighting is obtained from steam engines. The engines for driving the machinery are two in number, though only one is required to run at a time. They were made by the Buckeye Engine Company, of Salem, O., U. S. A., and are of the horizontal single-cylinder type. The cylinders are 13 × 28 inches, and the engines run at 150 revolutions per minute. For the lighting a horizontal Buckeye engine, with a cylinder 11 × 18 inches, running at 210 revolutions per minute, drives by belts two compound wound two-pole dynamos made by the Akron Electrical Manufacturing Company, Akron, O. These run at 670 revolutions per minute and give 250 amperes at 125 volts. Two further single-cylinder horizontal engines, which run at a maximum of 126 revolutions per minute, and have cylinders 9 × 16 inches, are each coupled direct to a blowing fan 10 feet in diameter, the functions of which will be explained later. All this machinery is contained in the engine room. Adjoining the engine room is the boiler house, which contains three double furnace water-tube boilers, each of 150 horse power, made by the Stirling Boiler Company, of Chicago. Two are continuously running. The usual working pressure is 115 pounds, though the valves do not "blow" till 125 pounds pressure is reached. The boilers are hand-fired. A dirty coal is used, but the smoke is not excessive. In addition to the coal, the furnaces are fed with the broken chips of wood made in the manufacture of the matches, which are collected and delivered into shoots leading to the furnaces in a way proceed to describe the processes carried out in various parts of the factory.

The greater portion of the matches manufactured in the factory are made on the fourth or top floor. There are in all sixteen machines at work on this floor, which consists of one room. They cut the matches from the block, paraffin and tip them, and when dry pack them into boxes nearly entirely automatically. In the usual type of machine, forty-eight matches are cut at every stroke of the cutters or dies, and there are from 150 to 230 strokes a minute, varying with the size of the machine. After the sticks are cut, they are automatically placed in holes in a traveling flexible cast iron band, from which they project like bristles. This

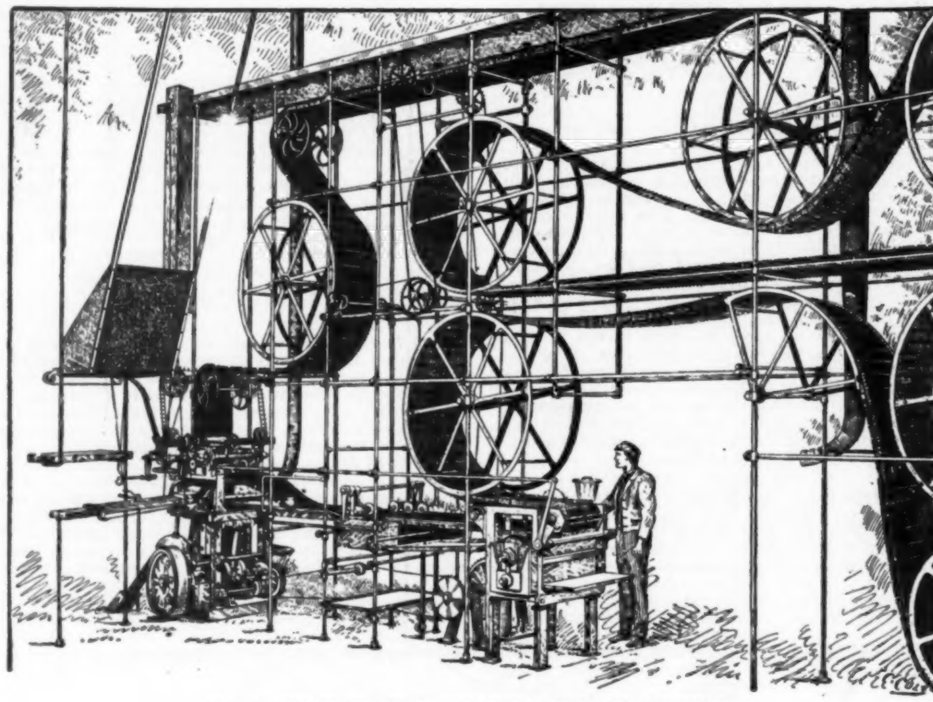


FIG. 1.—SIDE VIEW OF MATCH-MAKING MACHINE.

hereafter described. A sheet iron flue communicates with each boiler, and is taken to a circular brick chimney, detached some few feet from the engine house. This chimney is 125 feet high and 6 feet internal diameter at the top.

The deliveries from the fans above mentioned are taken into a chamber in which is a radiator, through which the exhaust steam from the engines can be led. From thence the air travels by three underground pipes to various portions of the building, and is led to all rooms by means of galvanized sheet iron trunks. In winter this serves a double purpose—that of heating and ventilating. In summer the steam is not used, and the apparatus is simply employed for ventilating. In all match-making rooms the rate of air supply is such that the whole of the air can be changed in from four to five minutes. This change and movement of the air, besides being very beneficial to the health of the workpeople, is useful for the drying of the matches during the course of their manufacture. We will now

traveling band is made up of plates 4 × 19 inches, hinged at the ends, and provided on the underside with teeth, by means of which it is carried over twenty-four sets of wheels of varying diameters which are kept revolving by chain gearing. The length of time taken by the traveling band to make one revolution is about an hour, and by this time the matches are quite dry and fit to pack. The boxes in which they are packed are placed in a channel by hand, and are automatically fed forward in front of the revolving band; the completed matches are punched out of the band, fall down into the boxes, which are kept continually shaken, and are carried forward and delivered into a revolving table, in the middle of which is a circular receptacle holding box covers. Girls pick up the filled boxes and put them in their covers. Figs. 1 and 2 show side and front views of the working parts of these machines, the remaining length of band being only necessary for drying purposes.

The process of manufacture of the matches is as follows:

The blocks of wood from which the matches are made come either from Canada or the United States, cut to the sizes requisite for the different sorts of matches. These blocks of wood are placed in the proper position, with the grain in the requisite direction, between two guides, and on two endless leather traveling bands. A boy does this, and just puts sufficient pressure on the blocks to insure their touching one another. The blocks get carried by the bands between two fluted rollers, which grip them and force them forward toward the dies or cutters at such an angle as to prevent waste of wood. The dies or cutters are small steel bars of rectangular cross section, having a hole the size of the match to be cut drilled in them near one end. The lower edges of these are sharpened by grinding. These are placed together side by side in rows of 48 or more, the whole number being moved up and down together by the action of a cam. By this means the match sticks are cut on the downward stroke; a plate then ascends under the bottom of the match sticks just cut and drives them into the holes in the flexible revolving band, as before mentioned. This is done so quickly that the motion of the band is apparently not felt and the matches are rarely if ever broken. If, however, they should be broken in this process, or if they are broken while being cut, there is an automatic means of withdrawing them from the machine. In each room where match-making is going on there is a fan at work, and a branch from its suction pipe is led behind the cutters of each machine. The broken match sticks are sucked into the branch, taken to the fan, and then forced along a trunk leading to cowls on the top of the boiler house. These cowls being open to the air, of course relieve the pressure, and the matches fall by gravitation into the boiler furnaces as before mentioned. Casually observed from time to time, this does not appear to be an unmixed blessing, as far as keeping steady steam is concerned, for the supply of broken sticks is by no means regular. But this, perhaps, is of small importance to the fact that the machines cannot get choked through broken bits of wood remaining in them. No completed matches are sent down these shoots. If any completed matches become broken or otherwise of no use, they are collected, put into boxes, and taken down to the boiler furnaces, where they are put in by hand. These, of course, take with them some phosphorus, and it would appear from remarks made by the stoker that this substance seems to have

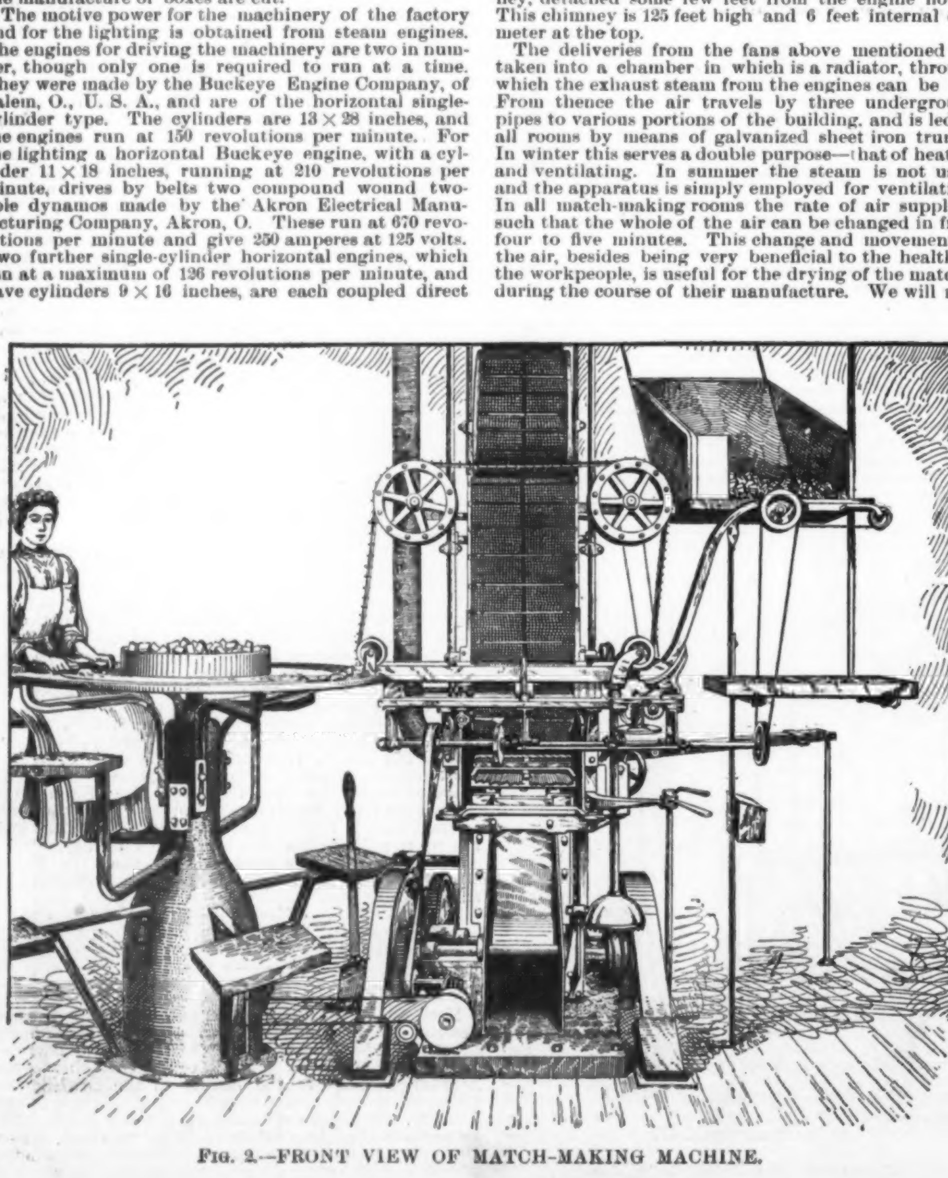


FIG. 2.—FRONT VIEW OF MATCH-MAKING MACHINE.

a deadening effect on the fire, and causes the formation of a hard and unbreakable clinker, besides making the fire comparatively useless for hours.

The match sticks having been cut and put in the traveling band, are carried forward with their points downward, and are first of all allowed to dip to the extent of about one-eighth of an inch into a bath of melted paraffin wax. An ingenious device always keeps the melted paraffin in this bath at the same level. There are two parts of the dipping bath—one the bath proper and the other a reservoir. There is an overflow from the bath to the reservoir; into this latter reservoir a small bucket keeps on being lowered and then raised automatically, coming up, of course, filled

10-inch by 10-inch pitch pine vertical supports, placed 10 feet apart. On every one of these there is fixed a hose with 50 feet of piping, which is attached to the town mains and to a special supply tank. In addition to these there are attached to the under side of the ceilings, every 10 feet in every direction, a Grinnell sprinkler nozzle, of which there are some 1,600 in various parts of the premises. All floors of the factory and all the offices are thus protected. All openings are fitted with doors and shutters coated with metal, which close automatically on the outbreak of fire.

On the third floor there is in the main building the box-making, etc., department and the machine and fitting shop. All boxes of all kinds are made on this floor. A certain amount of the printing of wrappers, etc., is also carried on here by means of two power-worked machines. There is also a guillotine for cutting paper, cardboard, etc., and a strip-cutting machine for the strips which are inserted in the larger boxes to prevent the matches falling out when the boxes are opened. There is also a strawboard cutter, which is capable of dealing with rolls of strawboard 57½ inches wide, weigh-

out from sixty-five to seventy boxes a minute, and there are thirty-nine of them of various sizes.

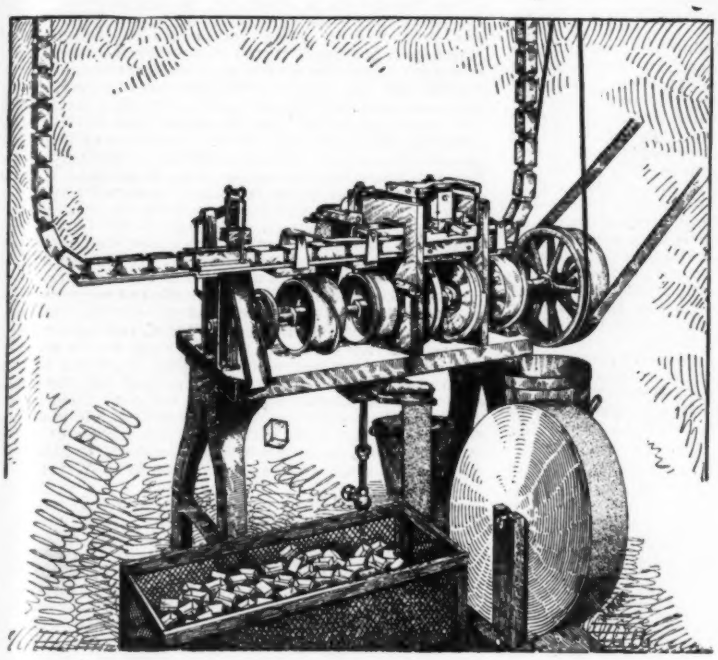


FIG. 3.—STRAWBOARD BOX-MAKING MACHINE.

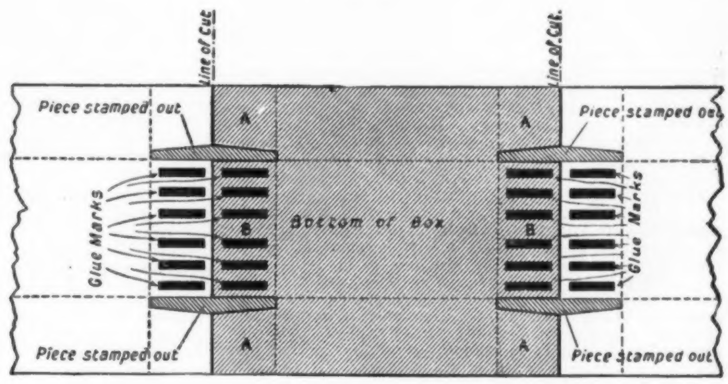


FIG. 4.—CONSTRUCTION OF STRAWBOARD BOX.

with melted paraffin wax, kept melted by means of exhaust steam from the engines; and when it reaches its highest point it meets a stop, and is tilted over till the paraffin flows into the dipping bath, and if this be too full to contain it, all the surplus flows back over the overflow into the reservoir.

Having passed through this bath, the match sticks, now having their ends impregnated with paraffin, are carried forward some little way until the paraffin has set, and their points are then made to impinge on an iron roller which works in a bath of "composition" containing the requisite ingredients for making match heads. The roller, which gets a coating of composition on its surface, revolves at the rate the match travels forward, so as to make the heads even and prevent their becoming one-sided. Should it become necessary to stop the band for any reason, it can be lifted clear of the roller and prevent damage to the matches. As regards manufacture, the match is then complete, and only needs to be dried before it can be packed. As previously stated, the match is dry when it has made one journey round the machine. The punch used for removing the matches from the band consists of a steel bar provided with pegs of a corresponding number to the number of holes in the breadth of the revolving band—usually forty-eight. The punch moves backward and forward, actuated by a cam, which works in such a way that the punches are exactly opposite the holes at the proper moment, and take into account the increased distance between consecutive lines of holes which come where there is the joint between two plates of the traveling band. Certain of the machines are larger than the one at present described, but they only differ in the breadth of the band. All corresponding parts in all machines of the same size are interchangeable. The structure forming the framework for the machine is of ordinary gas pipe, some of it 1 inch and some ¼ an inch. A usual size of machine is about 23¾ inches broad, 15 feet high, and some 63 feet from end to end.

When the matches have been put in their boxes, and the boxes in their covers, they are again put on the revolving table until they come opposite a shoot, into which they are pushed or thrown by hand. They then slide down on to a table, and are packed by girls into packets of twelve boxes, and these again into packets of twelve. Three or four hands can keep pace in wrapping with the output of a machine. Altogether, the number of hands employed to work a machine and pack up the matches is twelve or thirteen. Such a machine turns out on the average 500 gross of boxes, each containing, say, sixty matches, in ten hours—nearly 4½ millions of matches—the remainder between this and the possible output of the machine representing breakage and "wasters."

The floors of the room in which these machines are at work, as well as the floors in the other parts of the factory, are made of joists 8 inches by 2¾ inches, laid on their sides. They rest on cross joists of hard wood, 16 inches by 6 inches, of which two are bolted together with small distance pieces, and placed every 10 feet, and on the top of the upended planks comes a flooring of 1 inch maple. It is claimed that this method gives the building great fire-resisting qualities. In parts of the factory the 1 inch maple flooring is omitted.

This room is well lighted, both with windows all along one side of it and at the two ends, and also by means of a "ventilator," 12 feet by 4 feet, which runs the whole length of the room, and is provided with windows which are capable of being opened. The room is 310 feet long by 72 feet wide. The roof is carried on

ing from 600 to 850 lb. each. These rolls are cut into strips of any desired width, which are coiled separately on rollers. "Chip" boxes, in which the chips are fastened together by pasted paper, are also made by hand on this floor in small quantities; but by far the greatest interest centers in the automatic machinery for making the boxes and the box covers.

The strawboard boxes are made automatically from the strip. The shape into which the material is cut, and the places where it is scored, are shown in Fig. 4. The strip is first scored by sharp wheels, so as to bend easily, and then glued at regular intervals by means of an arm worked by a cam. The arm has twelve projections upon it, and it works up and down, in and out of a vessel containing melted glue, touching the cardboard at the top of its upward stroke, thus making a series of glue patches, as shown in Fig. 4, which will make the description clear. The strip is then fed forward, and holes are punched in it at regular intervals beside the glue marks, as shown. These pieces are the only waste which there is. All waste pieces in this process, and in all others connected with this factory, are collected, bundled, and sent away to be remade into strawboard. Having been glued and punched, the strip is automatically cut into suitable lengths, the line of cutting running between two sets of glue marks, as shown, and the piece cut off is then caught by a descending die, the edges, *A*, being turned upward and inward, and the edges, *B*, being pressed upward against them, and the box thus formed is forced into a metal former—a number of which are joined together in a continually revolving band—in the machine, Fig. 3, in which it travels for one revolution of the band, when it is dry. On arriving at a certain part of the machine—the end of their travel—they are automatically released from the "former," and fall into wooden crates covered on the sides and bottom with wire netting placed in front of the machine. Each machine will turn

AN AUTOMOBILE STREET SWEEPER AND SPRINKLER.

JUDGING from Paris, it would seem as if there were nothing more difficult than to sprinkle streets intelligently. Our sprinklers convert the streets into lakes of slush, and no matter whether it rains or whether it is fine weather, there is always mud in Paris. The engineers of the municipal service, having eyes, have finally perceived that street sprinkling, such as it is practiced in this city, is a calamity, and have recently been making some interesting experiments with a view to improving the system. It has occurred to them to convert the water into a spray sufficiently fine to prevent it from inundating the street. This spray comes from a pipe provided with nozzles, and the earth that it moistens is immediately swept up mechanically. The broom gathers up the mud from the gutters also, and this with the moistened dust is thrown into the sewer. In principle, the new system necessitates the addition to the ordinary sweeping machine of a reservoir of water and of a pump for injecting, under pressure, the water necessary to do the sprinkling. But, since this double apparatus is too heavy to be drawn by a horse, recourse had to be had to an inanimate motor.

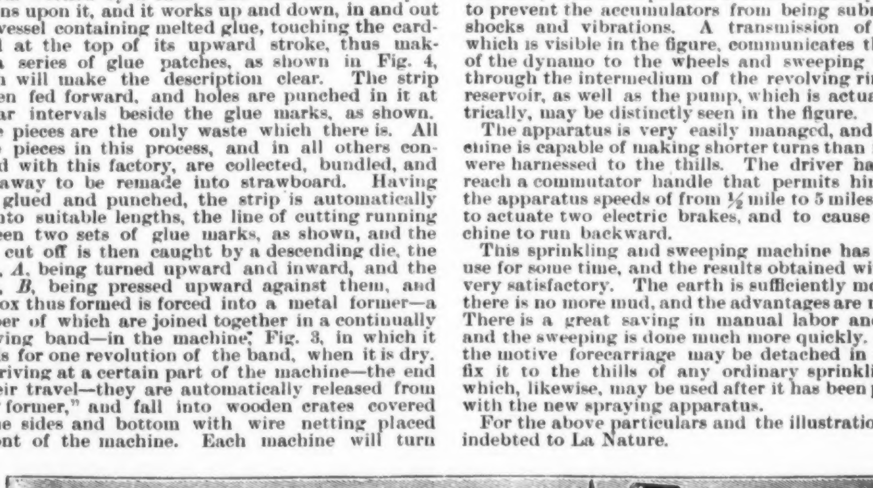
It occurred to M. Locherer, engineer of the first section of the municipal service, to make an application here of the new tractive forecarriage devised by MM. Amiot and Peneau, and which figured at the last exposition of automobiles.

A horizontal ring is suspended by stirrups from the thills of a sweeping machine, and beneath this revolves another ring, which is installed upon a frame mounted upon wheels through the intermedium of springs. Upon this same frame is arranged a Patin electric motor supplied by accumulators placed in the same frame and mounted upon springs that give the whole great elasticity. In fact, since wheels with iron tires are used, such a suspension became necessary in order to prevent the accumulators from being submitted to shocks and vibrations. A transmission of motion, which is visible in the figure, communicates the power of the dynamo to the wheels and sweeping machine through the intermedium of the revolving ring. The reservoir, as well as the pump, which is actuated electrically, may be distinctly seen in the figure.

The apparatus is very easily managed, and the machine is capable of making shorter turns than if a horse were harnessed to the thills. The driver has within reach a commutator handle that permits him to give the apparatus speeds of from ½ mile to 5 miles an hour, to actuate two electric brakes, and to cause the machine to run backward.

This sprinkling and sweeping machine has been in use for some time, and the results obtained with it are very satisfactory. The earth is sufficiently moistened, there is no more mud, and the advantages are manifest. There is a great saving in manual labor and water, and the sweeping is done much more quickly. Finally, the motive forecarriage may be detached in order to fix it to the thills of any ordinary sprinkling cart, which, likewise, may be used after it has been provided with the new spraying apparatus.

For the above particulars and the illustration we are indebted to La Nature.



AN AUTOMOBILE STREET SPRINKLER AND SWEEPER.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Growth of German Industries.—Germany is enjoying an era of unprecedented activity, if not prosperity, says United States Consul J. C. Monaghan, of Chemnitz. The persistency with which Germans study foreign methods of agriculture, commerce and manufacture has resulted in as successful a system as will be found anywhere. In one month—June, 1899—1,600 new building projects were noted in the nation's newspapers. Comparisons are often made with England and the United States, and in these comparisons Germany seldom or never suffers. Of the 1,600 projects reported for the month of June, the railroads numbered 300; electric roads, 73; factories, 212. Of these factories, 43 were for railroad supplies, 20 for stone works, 22 for mines, 16 for gas works, 14 for textile branches, and 10 for building industries. Among 122 electric plants projected, 96 are for factories and central stations, 26 are lighting plants for towns, etc. There were 184 waterworks projected, and of these 118 were for large waterworks or sewer systems, 19 for large bathing establishments, 13 for canals. There were also projected 71 churches, 100 sanitariums, 114 schools, and 142 large buildings. Of these, 92 are to be government buildings — post offices, prisons, court houses, city halls, and town buildings. In the list are 50 theaters, museums, villas, etc., against 20 in May. Besides all these, June saw 38 railroad stations and 25 large bridges projected. During the month of June 47 large factories were either partially or entirely destroyed by fire. These are to be rebuilt.

What value have these facts for us? It is well known that many of our house, electric-station, office, and factory equipments are far superior to any made here. It is a source of wonder that the Germans, in many ways as practical as any people on earth, have not adopted American locks. House after house, factory after factory, have gone up equipped with locks little less cumbersome than those of the middle ages. Keys weighing from an ounce upward have to be lugged around by any one wanting to enter his house without calling a servant. A number of the water-closet fittings find their way in from England. We should be able to sell a great many ornamental woods for finishing and decorating purposes. Our tools, too, so much simpler and better than the ungainly and clumsy ones used here, ought to make their way among a people willing to adopt anything new, if it promises to pay. Time, material, and money-saving machines must sell. The tools and machines of no other people are so much copied as are ours.

It may interest American manufacturers to read a great French writer's remarks on Germany's industrial progress in recent times. Emile Gautier says:

"All thoughtful minds to whom patriotism is something better than a mask for sowing dissensions feel more or less certain that France is losing her hold and position among nations in the industrial arena. The fact is forcing itself upon us that business is bad: and that if it goes on as it is going on at this moment, and as it has been going on for some time, our competitors, particularly Germany, will take the food from our mouths — literally eat the butter from our bread. Some people, far from pessimistic, prophesy that the world's exposition in 1900 will be an industrial Sedan, if not a Waterloo. Every national industry is affected. The manufacture of jewelry, essentially a Parisian specialty, is threatened. Twelve years ago I was told in Pforzheim, a small city in Baden, on the borders of the Black Forest, that that city furnished Paris and, through Paris, a large part of the world with jewelry. Two industries in particular which play prominent parts in modern civilization and industrial developments, the chemical and electrical, are hurt most. The wounds are seemingly deep and incurable. The chemical industries are tumbling to pieces. Years ago the cry was first sent forth; it was not heeded. Since then Germany, toiling unceasingly, moving with gigantic strides, has gone on until to-day it is master or mistress of the world's chemical markets, supplying four-fifths of the total demand. All nations, including France, pay Germany tribute for the necessary and profitable products used by apothecaries.

"It is the same with electricity. A 500 page book, just out, puts Germany's position in electricity in a very bright light. The book is entitled The Distribution of Electrical Energy in Germany (Die Verteilung der Elektrischen Energie in Deutschland). Charles Bos, an ex-Parisian city councilor, an electrical engineer of Paris, and one J. Lafargue tell of their travels in Germany. The people in this empire lent willing hands to help make the book as perfect a piece of advertising as possible, by lending excellent illustrations and photographs. One can notice that it is only the French who believe in industrial and military secrets. Almost everywhere else, manufacturers are so sure of themselves that they scorn petty and annoying regulations. They open wide the doors to visitors.* That is the rule in Germany, continue the writers referred to. Germany does not lose by this boldness. The progress in electricity is astonishing. One can count not less than forty companies with a capital of at least $90,000,000. These pay dividends running from 7 to 25 per cent. The field of their activities is not bounded by the borders of the empire: the whole world is full of their fame. It is all the more astonishing when one remembers that the year 1891 saw the beginning of the large plants. Since then one company alone, the Allgemeine Elektricitaetsgesellschaft, turned off and delivered, from 1896 to 1897, 5,189 machines, erected more than 100 central stations, and equipped and started 65 railroads.

"How is this progress, unprecedented in the history of the empire, to be explained? As a rule, victory and defeat are always deserved. Doubtless, the Germans had trumps in their hands—first of all, the fame of their arms, which assured them customers, because it encouraged self-reliance and obedience to the moral as well as to the political authority of the country; again, the low prices of wages and the surplus coal; finally and principally, German patience, perseverance, disciplined forces, race characteristics. Still, all these would not have availed without a fixed programme carried out with mathematical severity and in accordance with a system. Filled with an ambition to make their industrial and commercial achievements equal to their military record, they went to work resolutely, uniting all their efforts on one and the same object. The governments and every public power contributed their share. May the exhibit to be presented by the Germans at Paris in 1900—which, according to the opinion of experts, threatens to be an apotheosis—convince the good people of France that it is necessary to shake off the palsy under which our country seems to suffer. She must do this if she is to avoid death and complete ruin. This is the voice of one crying out in a wilderness of neglect and wanton indifference."

* This is not borne out by facts as I have found them; at least, it is hard to reconcile it with my own ten or eleven years' experience in certain lines. The efforts being made just now to keep foreigners out of the technical, industrial, and industrial-art schools do not tally with M. Gautier's statement.—J. C. M.

Artificial Paving Stones in Germany.—Under date of July 29, 1899, Consul Monaghan, of Chemnitz, sends the following:

Artificial paving stones are being successfully produced in this empire. The demand, in large cities, is so great, and the expense attached to their production under former methods is so large, that any improvement on the older systems, whether in saving money or in producing a better stone, will be welcomed by almost all countries. The newest process here is to mix coal tar with sulphur and warm thoroughly; to the resulting semiliquid mass, chlorate of lime (Chlorkalk) is added. After cooling, the mass is broken into small pieces and mixed with glass or blast-furnace glass slag (Hofenglasschaum). This powder is then subjected to a pressure of 200 atmospheres and reduced to the form or forms wanted. The specific weight of these stones is 2·2; the resistance against crushing is 143 kilogrammes (315 pounds) to the square centimeter (15⅛ square inches). The resistance to wear and tear in use is fully half as great as that of Swedish granite. Thus it commends itself through durability equal to that of many stone roads, resistance to changes of temperature, roughness of surface—giving horses a good foothold—and finally non-transmission of sound. Inasmuch as the joinings are very small, dirt is avoided and cleaning is very easy.

Electric Tramways in Nice.—The following, dated Nice, August 11, 1899, has been received from Vice-Consul Piatti:

In the course of an interview which I had yesterday with the mayor of Nice, I learned that the new electric tramways which were to be operated about October 15 will, until the 15th of December, be run by horse power. The reason given is that the existing telephonic wires are not of sufficient strength to resist being affected by the power used for the tramways, so that they must be replaced by strong cables placed underground; but not a single concern, it is said, can be found in France to deliver the necessary cables before November 1.

This, in itself, may not be a fact of paramount importance; but, reverting to the continuous attempts made by this consulate to induce our manufacturers to cultivate the very considerable opportunities offered by the port of Nice for a direct trade with the United States, it may not be out of place to say that in this instance an American firm might have competed with success in furnishing the necessary electric cables.

Electric Plants in Germany.—A most interesting feature of this empire's development is found in the number of electric plants in course of construction and projected, says J. C. Monaghan, consul at Chemnitz. French writers, notably Emile Gautier, Charles Bos, and J. Lafargue, are trying just now to arouse French emulation. It seems to me that American manufacturers might obtain contracts to furnish some of the materials needed in the plants. A large company has been organized here to build an electric railroad from this city (Chemnitz) to Burgstaedt, 12 or 15 miles away. As projected, the road is to run through many large and important villages. If continued to Mitweida, as some think it will be, should no rival concern open an opposition line, the distance covered will amount to 30 or more miles. There is also a project to build a central electric plant for supplying the road with power and the villages through which the road is to pass with electricity for light. Chemnitz has a population of nearly 200,000 souls; the towns included in the plans referred to contain about 75,000. The company expects to expend $357,000 on the road, and a similar amount on the buildings. Besides this, a cable road is being surveyed to Augustusberg, a well-known resort a few miles outside the city. While the disposition to patronize home industries is very strong here, I cannot help thinking that we must have certain things which, once seen, would win their way to favor.

An interesting question is: How can an American house hope to obtain concessions or contracts? The best way, it seems to me, would be to send one or two experts, familiar with electric plants, and their needs, to study the situation. What is true of Chemnitz is true of almost every city in the empire. In the month of June there were 330 railroads projected in the empire. Of these, 73 were electric roads; 122 electric plants were projected during the same time. It would be easy for an expert to keep himself posted, by visiting or communicating with the United States consuls-general in Berlin, Frankfort, and Dresden. Patriotism has seldom been pushed so far as to force private companies to take inferior or dearer home products.

The market here just now is so large—consequently so important—that an effort should be made to sell in it, even at the risk of not making a great deal of money at the outset. The methods that have helped at home must help here. A report made by an expert who has gone carefully over the ground would supply specific details in a way not possible to consuls.

Iron Bedsteads for the Orient.—Although statistics show us that American hardware is finding a rapidly increasing market abroad, there has as yet been but little imported into Formosa, says U. S. Consul James W. Davidson, of Tamsui. The foreign population of the island number but some three dozen persons in all, and, of course, their requirements are very slight. American manufacturers must then look to the Japanese and Chinese population for their customers. Unfortunately, both Chinese and Japanese carpenters still cling to their very primitive home-made tools. Although the more intelligent among the Japanese people are quick to purchase labor-saving machinery if the expense is not too great, and they are convinced work can be done by it cheaper and quicker than by hand, this spirit of enterprise does not apparently extend to the carpenter, or even the blacksmith, and lower-class artisans who live in the interior and feel but little the influence of foreign customs.

I have visited several of the large hardware shops in the city, and with the exception of nails, bolts, screws, locks, hinges, and shovels, I have found no foreign goods.

Although there is but little to be done in hardware, it is my firm belief that a good opportunity exists for the introduction of American iron beds, not only in Formosa, but throughout the East, provided the home manufacturers are willing to make the slight modifications required in producing an acceptable article.

The American iron bed, enameled in white and with brass trimmings, is superior in appearance to the English or Continental bed found for sale in the East; and, although in every way equal in strength and firmness, it is manufactured in America at such a low cost that it can be placed on the Eastern market at about half the cost of the European article. The plague of insects is so prevalent in the East, and wood is so easily injured by the excessive damp, that wooden bedsteads find but little favor. The form of bed most suitable for use in tropical countries differs from the present American model in two respects, i. e., the body of the bed must be raised so as to be two feet clear of the floor, and the four posts must be extended to a length of seven feet. A mosquito net is used the year round in most tropical countries, and although an ingenious canopy arrangement, to be suspended from the ceiling, can be obtained in the United States, the only really satisfactory net is the one supported by the four bedposts, independent of outside fixtures. The four posts should be connected at the top by light rods, bent at each end into a ring, which can be dropped over a pin which projects from the top of each post and which also affords a hold for the brass knobs which are to be placed on top. This frame forms a support for the mosquito net, which is either fastened to the rods with loops or is drawn over the whole frame. An English or Continental double bed of this kind sells in the East for from 40 to 50 yen ($20 to $25).

Although foreign-style beds are but rarely used by Japanese in Japan proper, well-to-do Japanese in Formosa use them quite extensively, as they recognize that in this damp climate it is more healthful to sleep above the floor than on the "tatami," as is done in Japan. In some of the government institutions—especially the hospitals, of which there are several large ones in Formosa—foreign iron beds are used exclusively. The largest market, however, would be in supplying the thousands of foreigners who reside in the various foreign settlements throughout the whole East.

Tinware in South Africa.—Under date of July 28, 1899, Consul General Stowe, of Cape Town, transmits the following information relative to the use of tinware in South Africa.

The principal fruit canner in Cape Town is the firm of Hill & Company. There are fruit canners in East London, Port Elizabeth, both in Cape Colony, and in Durban, Natal. There are houses outside of these engaged in canning fruit in all those cities, and in position to sell tinners' machinery when a demand therefor arises. The little machinery used in can making comes from the United States and England. The American sales are made through New York commission houses, whose representatives are regular callers at Cape Town. The local tin working is of such minor importance that I have been unable to find a tinner who could make some "gem pans."

George Finley & Company and Woodhead, Platt & Company, both of Cape Town, would handle tin-working machinery and tools. Tinners' machinery is free of duty, while tinware is subject to a duty of 9 per cent.

New Ports Opened in Japan.—Under date of July 15, 1899, Minister Buck sends from Tokyo translation of an imperial rescript naming additional ports to be opened to foreign trade under the operation of the new treaties, as follows:

Art. 1. Besides the open ports hitherto designated, the following are to be also open ports:

Shimizu, Suruga Province.	Shishimi, Tsushima Province.
Taketoyo, Owari Province.	Nawa, Ryuku Province.
Yokkaichi, Ise Province	Hamada, Iwami Province.
Shimonoseki, Negato Province.	Sakai, Hoki Province.
Moji, Buzen Province.	Miyazu, Tango Province.
Hakata, Chikuzen Province.	Tsuruga, Echizen Province.
Karatsu, Hizen Province.	Nanawo (South Bay), Noto Province.
Kuchinotsu, Hizen Province.	Fushiki, Etchu Province.
Misumi, Higo Province.	Otaru, Shiribeshi Province.
Izuhara, Tsushima Province.	Kushiro, Kushiro Province.
Sasuna, Tsushima Province.	Muroran, Iburi Province.

Art. 2. At the port of Muroran, only mugi (barley, wheat, rye, oats, etc.), sulphur, coal, and other commodities designated by the minister for finance, can be exported.

Art. 3. If in any of the ports named in article 1 the total amount of imports and exports of commodities comes short of 50,000 yen ($24,900), the said port is to be closed.

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No. 532. September 19.—Russian Cattle for England—Bill for Montevideo Port Works—Misrepresentations Regarding Jamaica—Tobacco in Spain.

No. 533. September 20.—Increase of Duties in the Transvaal: South African Trade Notes—Trade Regulations at Talienwan: New Siberian City—Collection of Debts in Paraguay—Collection of Debts in Salvador.

No. 534. September 21.—Cotton Textiles in Paraguay—Agricultural Conditions in Ontario.

No. 535. September 22.—*American Machinery in the United Kingdom—Flour in Madagascar—Russian-Siamese Commercial Treaty—Tin in the Straits Settlements.

No. 536. September 23.—Mining Bubble in Dutch India—Cultivation of Henequen in Venezuela—*Shipments to Chile—*Belgian Demand for Refrigerators—American Piece Goods in China—Trusts in Germany.

The Reports marked with an asterisk (*) will be published in the Scientific American Supplement. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

An excellent polishing medium for nickeled parts, says Farben Zeitung, is calcic hydrate, i. e., the residuum remaining from the generation of acetylene. It may be employed like white chalk, but excels the latter in polishing capacity. Only completely dry powder must be employed, however.

Cement for Zinc Ornaments.—According to the Praktischer Wegweiser, same is prepared from a soluble soda glass solution of 33° Bé. and fine whiting, with addition of zinc dust—so-called zinc gray. These products are stirred together into a thick mass, which after six to eight hours hardens into great firmness. It may then be polished with agate and assumes the glossy white color of metallic zinc, and defective polished zinc vessels and figures may be repaired with it.

Black Paint for Iron.—According to Invention, a black paint for iron objects is obtained by dropping concentrated sulphuric acid into oil of turpentine, stirring constantly. A sirupy precipitate forms, which, washed out with water, is used as a pigment. The painted article should be heated and then polished with a woolen rag and linseed oil. The coating is said to adhere excellently to metals and not to crack off, giving a handsome, glossy black color and protecting the iron from rust in an effective manner.

A good leather and belt grease is prepared as follows: Melt 1 pound of yellow ceresine, 1 pound of crude palm oil, and 5 pounds of inferior lard, and stir in, according to the season of the year, and whether a firm or soft consistency is desired, 4 to 6 pounds of vaseline oil. When all is thoroughly dissolved and mixed, pour into the cans or the receptacles destined for storing. If this odorless grease is well incorporated with the leather, it keeps the belts, as well as all leather goods, in constant pliancy and entirely prevents brittleness. It is essential to clean the leather thoroughly from all adhering dirt before greasing. Hardened belts must first be softened with warm water, and it is advisable to grease them while they are still moist.—Farben Zeitung.

Wood Paint Resisting Acids and High Tension of Steam.—According to the Baugewerks Zeitung, two parts, by weight, of gypsum and one part of pulverized asbestos are carefully stirred together with fresh ox blood into a thickly liquid paint. The perfectly dry wood is evenly coated with this mass and the painted article left to dry. After a few hours another coating is applied, a little linseed oil varnish being added to the paint. According to whether a long or short time is at disposal to complete the work, the painted objects are allowed to dry for a few days in the air or over a small wood fire. Now steam is caused to act slowly on the painted wood, and it is dried some time before use. If carefully applied, the paint adheres very firmly, never peeling or cracking. The coating is cheap, and the substances employed are harmless, odorless, and tasteless, and consequently have no injurious effect upon liquids contained in vessels painted with it.

Stains for Work Tables.—Work tables that are exposed to the action of acids or alkalies, but should present a nice appearance in spite thereof, are stained with a resistive composition for which the Pharmaceutische Zeitung gives the following recipe:

SOLUTION A.

Copper sulphate	125	grammes.
Potassium chlorate	125	"
Water	1,000	c. cm.

Boil until all is dissolved.

SOLUTION B.

Aniline hydrochloride	150	grammes.
Water	1,000	c. cm.

Apply Solution A twice by means of a brush, allowing time to dry after each coat; next, put on Solution B and let dry again. On the day following, rub on a little oil with a cloth and repeat this once a month.

Hardening of Springs.—Above all, a variety of steel must be chosen which is suitable for the production of springs, a very tough quality with about 0·8 per cent. of carbon being probably the best. Any steel works of good reputation would no doubt recommend a certain kind of steel. In shaping a spring, forging and hammering should be avoided if possible. In forging, an uneven treatment can scarcely be avoided; one portion is worked more than the other, causing tensions which, especially in springs, must be guarded against. It is most advantageous if a material of the thickness and shape of the spring can be obtained, which, by bending and pressing through, is shaped into the desired spring. Since this also entails slight tension, a careful annealing is advisable, so as to prevent cracking or distorting in hardening. The annealing is best conducted with exclusion of the air, by placing the springs in a sheet iron box provided with a cover, smearing all the joints well up with loam. The heating may be done in a muffled furnace; the box, with contents, is, not too slowly, heated to cherry red and then allowed to cool gradually, together with the stove. The springs must only be taken out when they have cooled off enough that they will give off no hissing sound when touched by water. In order to uniformly heat the springs for hardening, a muffle furnace is likewise employed, wherein they are heated to cherry heat. For cooling liquid, a mixture of oil, tallow, and petroleum is employed. A mass consisting of fish oil, tallow, and wax also renders good service, but one should see to it that there is a sufficient quantity of these cooling liquids, so that the springs may be moved about, same as when cooled in water, without causing an appreciable increase in the temperature of the liquid. In most cases too small a quantity of the liquid is responsible for the many failures in hardening. When the springs have cooled in the hardening liquid, they are taken out, dried off superficially, and the oil still adhering is burned off over a charcoal fire. This enables one to moderate the temper according to the duration of the burning off and to produce the desired elasticity. An even heating being of great importance in hardening springs, the electric current has of late been successfully employed for this purpose.—Werkmeister Zeitung.

SELECTED FORMULÆ.

Horticultural Receipts.—

GRAFTING WAX.

1. Beeswax	75	parts.
Purified resin	125	"
Turpentine	36	"
Rape oil	12	"
Venice turpentine	25	"
Zinc white	25	"

Color yellow with turmeric.

2. Japan wax	100	parts.
Yellow wax	300	"
Resin	800	"
Turpentine	400	"
Hard paraffin	100	"
Suet	300	"
Venice turpentine	600	"

FLUID GRAFTING WAX.

1. Resin	1,250	parts.
Pitch	200	"
Linseed	120	"
Turpentine	0·50	"
Yellow wax	130	"

Melt with a gentle heat; stir continually until cold and then add methylated spirit, 400 fluid parts.

2. Burgundy pitch, 500, is melted slowly, removed from the fire and mixed with alcohol 70 or 80. Put up in wide necked bottles or tins.

3. Turpentine.

Resin	1	part.
Wood alcohol	4	"

MANURE FOR INDOOR.

1. Sodium chloride	10	parts.
Potassium nitrate	5	"
Magnesium sulphate	5	"
Magnesia	1	"
Sodium phosphate	2	"

Mixed and bottled. Dissolve a teaspoonful daily in a liter of water and water the plants with the solution.

2. Ammonium nitrate	40	parts.
Potassium nitrate	90	"
Ammonium phosphate	50	"

Two grm. is sufficient for a medium sized flower pot.

3. Ammonium sulphate	10	parts.
Sodium chloride	10	"
Potassium nitrate	5	"
Magnesium sulphate	5	"
Magnesium carbonate	1	"
Sodium phosphate	20	"

One teaspoonful to one liter of water.

4. Ammonium nitrate	40	parts.
Ammonium phosphate	20	"
Potassium nitrate	0·25	"
Ammonium chloride	5	"
Calcium sulphate	6	"
Ferrous sulphate	4	"

Dissolve 2 grm. in a liter of water and water the plants with the solution.

5. Potassium nitrate	20	parts.
Potassium phosphate	25	"
Ammonium sulphate	10	"
Ammonium nitrate	35	"

This mixture produces a luxuriant foliage. If blooms are desired, dispense with the ammonium nitrate.

SHIELD LOUSE WASH.

1. Unslaked lime	18	kilos.
Sulphur	9	"
Salt	6·75	"

Mix as follows: A fourth part of the lime is slaked and boiled for two-thirds of an hour with the sulphur in 22·6 liters of water. The remainder of the lime is then slaked and added with the salt to the hot mixture. The whole is burned for another half-hour or an hour, and then diluted to 353 liters. The fluid is applied lukewarm when the plants are not in active growth.

2. Sulphur	900	grm.
Caustic soda	674	"
(or concentrated ammonia solution.)		
Train oil soap	7·5	kilos.

The sulphur and the alkali are boiled in water for one hour, the soap is dissolved in 45·4 liters of boiling water. The solutions are mixed, boiled for half an hour, and diluted to 227 liters of water. Apply while warm.

3. Resin	9	kilos.
Caustic soda	2·25	"
or concentrated ammonia	2·25	"
or calcined 93 per cent. soda	15·75	"
Fish or train oil	1·4	liters.

All three substances are put into a kettle, covered with 3 or 4 inches of water, and boiled from one to two hours. The mixture is then diluted with water to resemble strong black coffee.

PETROLEUM EMULSION.

Train oil soap	2·25	kilos.
Boiling water	45·4	liters.
Petroleum	2·25	"

The mixture is diluted to 227 liters with hot water. Wash or spray with the lukewarm solution.

KREUGER'S PETROLEUM EMULSION.

Black soap	250	grm.
Water	4·5	liters.
Petroleum	9	"

Dissolve the soap by boiling in the water; after removing from the fire add the petroleum. The fluid is then agitated well for 10 to 15 minutes.

NESSLER'S REMEDIES FOR AMERICAN BLIGHT.

1. Soft soap	40	grm.
Amyl alcohol	50	"
Methylated spirit	20	"
Water	1	liter.
2. Soft soap	30	grm.
Sulphureted potash	2	"
Amyl alcohol	32	"
Water	1	liter.
3. Soft soap	15	grm.
Sulphureted potash	29	"
Water	1	liter.

—American Druggist and Pharmaceutical Record.

MISCELLANEOUS NOTES.

At the Allegheny shops of the Pittsburg, Fort Wayne and Chicago Company is a Class I consolidation locomotive, whose dome was knocked off by running into a limestone tipple. The sudden consequent release of the steam had a curious effect, in the nature of an explosion, on the boiler; the top of the Belpaire boiler being ripped open as if done with a knife, the sheets being torn from the stays and bent outward over each side. The boiler head was also somewhat damaged.

The Wilden process for coating steel and iron consists in the use of a bath composed of zinc, tin, and aluminum. This mixture, it is claimed, produces a coating on iron and steel superior to any now known, being so firmly adherent that the sheets will stand working after it has been applied, will resist corrosion and can be heated red hot without injury. The coating is applied by the same method as galvanizing, by dipping the cleansed sheets, etc., in the melted alloy. The most approved mixture is the following composition, by weight: Zinc, 84 per cent.; tin, 14; lead, 1·5; aluminum, 0·5 per cent.

Many varying opinions have been expressed by different investigators on the effect of arsenic on steel. In the Bulletin de la Société d'Encouragement de Industrie Nationale M. Marchel gives the result of some observations and experiments he has made on this point. His conclusion is that arsenic by itself has very little effect on the qualities of iron and steel. Considering the very small quantity found in most iron ores, there is no need of any special care to free the iron from this alloy. In some cases, however, it is possible that the arsenic may aggravate the effects of other impurities in the steel.

Eggs in cold storage warehouses in the United States at the present time are said to aggregate the very considerable amount of 2,855,000 cases, or 75,650,000 dozen, or 907,800,000 eggs. According to the published estimates of a prominent egg broker, says Ice and Refrigeration, more eggs are held in Chicago warehouses than anywhere else, Chicago being credited with over 700,000 cases. New York city comes next with 235,000 and then Philadelphia with 200,000 cases; Boston with 150,000 cases; Buffalo with 125,000 cases; Sioux City, Iowa, 125,000 cases; Providence, R. I., 100,000 cases. The States of Wisconsin, Indiana, Ohio, Minnesota, Iowa outside of Sioux City, and Pennsylvania outside of Philadelphia, are each credited with 100,000 cases. The stores at other points where there are cold storage warehouses make up the aggregate named above.

The Russian imperial authorities have recently definitely resolved to extend the Central Asian Railway to the town of Werny and thence in a northerly direction. It now remains for the direction of the new line to be decided upon. A detachment of engineers has already left Tashkend for the purpose of making a preliminary survey. Two routes have been suggested; one would be across the Steppes to Orenburg, to the southward of the Oural Mountains, and the other, by Semipalatinsk, to Baranaul and Krivoschtschekovo. The former route has very influential supporters in the persons of the cotton growers of Tashkend and the manufacturers of Moscow, all of whom naturally desire to have the shortest possible means of transit for conveying this raw material to Moscow. A recent conference at Semipalatinsk clearly proved that the route by that place and Barnaul will be the more advantageous. The authorities will, it is said, allow the new line to be built by private enterprise.

The results of some interesting tests on a floor and on a ceiling made last March and April by the British Fire Prevention Committee have just been published. The floor was constructed of solid wooden beams 9 inches thick, close bedded, and the joints were stopped with fire clay. The floor was subjected to a fierce fire for one hour, a temperature of 1,955° F. being attained near the end of the experiment. A stream of water was then applied for five minutes, and the whole rapidly cooled. Subsequent investigation showed that the under surface of the beams was charred to a depth of about 2 inches, but beyond this the timber was quite sound and unaffected. The ceiling tested was of laths and asbestic plaster, and was exposed to a temperature of about 500° F. for half an hour, the temperature being then slowly raised to about 1,500°, after which a jet of water was turned on for three minutes, and the whole rapidly cooled. On examination at the end of the test, the ceiling proved to be but little injured, and the application of the water caused no damage. No portion fell either during the test or afterward. Cracks had, however, developed over its surface, and some of the laths were charred, though none had ignited.

During the last three years the winding ropes in the Dortmund mine inspection district have been made exclusively of cast steel wire, two round iron wire ropes having been used in 1895 and two flat Manila fiber ropes in 1893, says The Engineering and Mining Journal. During the period of 27 years from 1872 to 1898, during which a strict record has been kept of all particulars connected with winding ropes, the proportion of breakages has gradually, and with tolerable uniformity, become reduced from 19·3 to 0·54 per cent. of the whole number. Last year out of the 369 ropes renewed at the 116 collieries, 316 were round and 53 flat. Two flat ropes broke suddenly, both of them having been made of wire drawn from mild cast steel by Bocker & Company of Schalke, one close to the drum when beginning the lift, after it had been in use 187 days and had raised a net load of 35,510,000 tons, and the other, also on beginning the lift, 250 m. (273 yards) below the pulley, after having been in use 246 days and having raised a net load of 13,280,000 tons. Out of the total number of winding ropes (all of steel wire) used in the district last year, 301 were ordinary round, 53 flat, 13 lock coil and 2 of the flat strand description, 5 of the first named having been in use more than 1600 days. The various reasons which determined the taking out of the ropes were breakage of individual wires in 200 cases, general wear in 70, changed conditions of winding in 33, too great reduction of length in 25, insufficient resistance to tensile strength as determined by testing the end cut off in 21, and alteration of form in 14.

THE LEMUR.

The name lemur, which means ghost or specter, was given to the animal by Linnæus on account of its nocturnal habits. More than thirty species are known, divided into five principal genera, inhabiting chiefly Madagascar, a few being found in Africa and the warm regions of Asia and its archipelago.

THE SPECTRAL LEMUR OF SUMATRA.

The head of the lemur is rounded, and the snout, in certain species, so elongated and pointed, that the animals are often termed fox-faced or fox-nosed monkeys; the legs are fairly long, the eyes large and in the front of the head, the ears small, the fur soft, and the tail generally long and bushy. The lemur is a pretty animal, gentle and playful in captivity. One of the most elegant of the species is the ring-tailed lemur, of a delicate gray color, ruddy on the back, white below and on the cheeks, with the tailed ringed with black and white; it received its specific name (catta) from its occasionally making a noise like the purring of a cat. The vari (L. macaco) is varied by large white and black spots. The red lemur (L. ruber, Péron) is of a reddish chestnut color, with head, fore limbs, tail, and abdomen black, and a white spot on the nape. The animals of this species are among the few in which the lower parts are darker than the upper. The red lemur is easily tamed, gentle, agile, but sleepy during the day; the body is about 13 inches and the tail about 1½ feet long. The name of mongous is popularly applied to all lemurs of an olive-brown color. The term maki is also synonymous with lemurs, most of the species being found in Madagascar.

The African lemurs or galagos have long tarsi, large naked ears, large eyes, and a long tufted tail; they feed on insects and plants, are nocturnal, and as agile as monkeys or squirrels. When sleeping they are said to close the ears like bats; the flesh is eaten by the natives of Senegal.

The dwarf lemur, with hairy ears, facial whiskers, and broad upper incisors, is sometimes called the Madagascar rat and is 10 or 11 inches long and 6 inches high; the color is grayish fawn above and white be-

low. The sprectral lemur, of which we have reproduced an illustration taken from Das Buch für Alle, is of a grayish brown color, and lives in the dense forests of the Indian archipelago; its long tarsi enable it to leap like a frog; the size is small. As a class lemurs are interesting as supplying transitional forms showing relationship to monkeys, bats, insectivora, and rodents.

THE SOUDANESE AT PARIS.

The Soudanese who, under the leadership of Commandant Marchand, made the expedition from the Atlantic to the Red Sea so brilliantly, have just spent at Paris three days that will constitute the principal event of their existence.

Upon their arrival at Courbevoie, Thursday, July 20, under the command of Capt. Mangin, Lieut. Fouque and Sergts. Bernard, Dat and Verrail, they were received by the Municipal Council and mayor of the locality. Confined strictly to quarters for the whole of Thursday, they prepared themselves for figuring correctly at the Longchamps review, which permitted the population of Paris to give them an ovation such as has rarely been witnessed.

For military reasons Commandant Marchand had been prevented from leading his men to the review. The brave officer, instead of being at the head of the Soudanese, where he was naturally looked for, had been obliged to join the Governor of Paris, to whose staff he belonged; and it was not until the Congo-Nile column passed in review before the president of the republic that he assumed command of it.

The Soudanese were preceded by the Twenty-ninth regiment of infantry, and as they marched with heads erect and their eyes fixed upon their officers, loud and prolonged applause rent the air, hats were thrown up by the men, and the women kept up a continuous waving of handkerchiefs.

Every one remarked the martial bearing of these African soldiers, and their evident desire to make a good appearance.

At night they were embarked at the Puteaux bridge in order to allow them to see the illumination of Paris. When the boat arrived in the vicinity of the Pont Neuf, it was anchored in order to permit them to witness a display of fireworks. The bursting of the first rockets caused great astonishment. "That is fine!" they exclaimed; "it is just as if a battle were being fought!" They looked as if fascinated at the spectacle of the fire that was reflected in the water, and, when asked what they thought of it, simply answered: "It is fine!" Their thoughts did not go beyond that.

The sail continued to a point in a line with the city hall, and then the boat turned about and took the tired excursionists back to the starting place, whence they marched to their barracks, happy to get a chance to rest.

Saturday was devoted to a general visit to the public structures of Paris. Long, open wagons were driven up to the Courbevoie barracks at an early hour, and in these, under the direction of officers of the fire department, the soldiers were taken to the Arch of Triumph, the Invalides, the Opera, the Pantheon, the Eiffel Tower, the great wheel, and the city hall, where they were received by the municipality.

At the Eiffel Tower the ascent was made amid the acclamations of a large crowd massed at the foot. Here some of the blacks remained immovable, some looked with curiosity at the panorama that was unfolded to their gaze, and a few exclaimed in an undertone: "Beautiful Paris; great Paris!" This was no

ARRIVAL OF THE SOUDANESE OF THE MARCHAND MISSION AT THE COURBEVOIE STATION

THE SOUDANESE LEAVING THE RAILWAY STATION

more ridiculous than any ordinary exclamation uttered by a more civilized tourist. Before putting foot upon terra firma, they were served upon the first platform with a light collation, consisting of sandwiches, biscuits and seltzer water. At the moment of putting his glass to his lips, Sergeant Mocktar-Kari rose and exclaimed: "Vive la France!" All the blacks repeated this cry and gave cheer after cheer.

In the evening the Soudanese were taken to a representation of the "Poudre de Perlimpinpin," given at the Châtelet Theater. This spectacle greatly excited their curiosity and evoked enthusiastic applause. At the close of the performance, Commandant Marchand came to take leave of his soldiers, who were to depart on the following morning. The adieux of the chiefs were very touching.

For the above particulars and the engravings, we are indebted to Le Monde Illustré.

THE LITERATURE AND LEGENDS OF THE FILIPINOS.

By MARGHERITA ARLINA HAMM.

IT seems strange that during the three centuries of Spanish rule no member of the governing race should have taken the trouble to make inquiries as to the mental possessions of the Philippine Islanders. While Spanish apathy may account for this in part, the real cause lay in the Spanish policy. They preferred to keep the natives as far as possible in their primitive condition, and they opposed any and every thing which would tend to develop the little brown men of the archipelago. The first knowledge of the literature and legends of the Filipinos came from that careful observer and scientist, Alfred Wallace. Since his time many travelers have made special studies in this field, and the information thus obtained throws considerable light upon the mental life of Tagal, Visaya, and Moro, using these terms in their generic significance.

The native literature is largely in the form of folklore, and consists of legends and traditions, ancient songs and ballads, and some curious dramas, religious and historical. The legends are recited in both verse and prose. One series is devoted to the old wars between the Tagals and the Igorrotes and another to particular heroes of each race. Before the landing of Legaspi at Manila there was a condition of comparative peace between these two races which had followed many centuries of war on both sea and land. The Spanish historians refer to these legends and name several of the princes or kings about whom they were woven.

Another class of legends are connected with the wanderings of the Malays before they had reached the northern part of the archipelago. They are songs of the sea and are full of the exaggeration and rude poetry which mark the savage mind. At times they resemble the traditions of the red men. Just as the Penobscot Indian tells tales of giant bears, elk, and panthers, so the Tagal and the Visaya have similar stories respecting enormous buffaloes, monstrous crabs, and titanic sharks. A fair example of these folk tales as told to me by the representative Filipinos is the story of the crab that tried to swallow the moon.

One evening just after sunset a beautiful princess was walking along the beach when she saw in the water an island which had not been there in the morning. She looked with astonishment at the rough outline, and was still more amazed to see that it was approaching the shore. She stepped behind the trunk of a great molave, so as to be invisible to any animal that might be on the island. It reached the shore, and then she saw it was not an island, but a crab larger than a hundred tamaraos (wild buffaloes). She knew the crab must be very hungry, because all the teeth of its hideous mouth were moving and its gripping claws were opening and closing as if getting ready to attack something. But there was no prey in sight, and the Princess was puzzled. Soon the moon (the bulan) began to rise, and the crab began to make ready to spring upon the luminary and drag it down into the sea. The Princess recognized the creature's intention, and, seizing her war conch, blew a great blast three times. Her tribe were feasting a half mile away and making much merriment and noise. Only one sick child heard the first blast, but when the second blast came every one started up and seized the nearest weapon. When the third blast came they knew there was some terrible danger, and they ran, men and women, where the sound came from. They arrived none too soon. The moon was half above the horizon and the giant crab was making ready to spring. The Princess explained the matter in a few words, and, leading her warriors, attacked the monster. She and the bravest warrior led the rest and sprang at their enemy with the war cry of the tribe. The crab turned in surprise, and as he turned the creese of the Princess cut off his great left claw. The warrior struck at the right claw but missed, and the next moment was crushed by the frenzied thing. Again the creese of the Princess descended, and this time the right claw fell off the misshapen leg. At the same moment a hundred creeses and as many spears struck the running legs and the joints where the back fits on to the belly. The crab fought bravely but without avail. He killed many of the tribe, but finally, cut and broken to pieces, he yielded up the spirit, and the moon was safe. Whenever a prahu sails the sea in the moonlight the wise captain says kind words to a little image of the Princess, but for whose bravery the sea would be as dark as a cavern.

In these legends all the animals have intelligence and a language of their own. Only one animal, however, understands the human tongue, and that is the dove.

There are several stories which suggest in a vague way the beautiful tale of the Pied Piper of Hamelin. In the Malay version the jungle fowl or bankiva possess the power of charming children by a special cry or call. But they are only allowed to use this power either one day of the year or one week of the year, when the spirits give them the privilege so that they can avenge themselves against their chief enemy—man.

The handsomest bankiva is selected by the flock to lead a procession of jungle fowl, who fly from the forest to the outskirts of the village and there give the call. Grown people do not hear it, but little children hear it and are intensely delighted. Babies turn in their mothers' arms and coo in response, and little toddlers hurry as fast as their feet can carry them to see the strange bird that produces the beautiful music. When they reach the little ring in which the bankivas are singing, spreading their feathers and dancing, they pause for a moment, and then, as the flock begins to move toward the forest, they follow unconsciously. Into the forest and into the marsh, into the lairs of serpents and into the haunts of alligators, the helpless innocents wander, drawn by the magic of the bankivas' call. They seldom return, and when they do, they come back as old men and women to whom the village of the morning is another and very different place.

The songs are very melodic, simple and attractive. They are used to keep time with dances and are sung some of them as solos and others as choruses. The love songs, oddly enough, never allude to kissing. Osculation is as rare among the Malays as among the Japanese. Indeed, it is rarer, because Japanese mothers kiss their babies, while Malay mothers seldom do. One of the chief expressions of affection between a young man and a young woman is to lock toes, and several songs are opened with an allusion to this extraordinary practice. A close approach to kissing is made by resting the nose and lips upon the cheek or neck of the other party and then drawing a deep breath. A third affectional action consists in rubbing cheeks, and a fourth in rubbing and patting the shoulder. The charms and virtues of the admired one are described in enthusiastic and exaggerated language. While many compliments are too barbarous to be translated, others display excellent taste. The goodness, kindness, purity, filial piety, domestic accomplishments, and agricultural talents of the heroine are sung in just about the same style as those of a daughter of the backwoods by her untutored swain. Songs of this class are very numerous and are in constant and universal use.

The Malays love music and dancing, the Tagals excelling all the other tribes. At births, weddings, and funerals, at the tribal council, the dedication of a meeting house, or upon any great religious festival, there is invariably a banquet with a dance and song. The songs are appropriate to the occasion in each instance. Besides these are special songs upon such topics as hujan, or the rain spirit, which is a particular favorite; upon the laut or the sea; upon bingtang, the favorite star; and upon the winds, waves, tides, and many burungs (birus), and other animals. The Tagal poet sees beauty in all these things, but singularly enough does not notice the mountains, the forests, scenery, or natural beauty in general.

The dramatic literature is extremely crude and at the same time very artificial. It would seem as if the Malays had been influenced by the Chinese stage across the sea. They employ, like the Chinese, very rich costumes, use an open platform without scenery or stage properties, and employ singsong delivery, which to the Caucasian ear is very monotonous and unpleasant. Their plays are of three classes. One is of a religious type, something like the miracle plays in old English civilization. A second class, which is more popular, is known as the Moro-moro, named after the Moros or Mussulmans of Mindanao and the Sulu Archipelago. These are heroic, or rather melodramatic, productions, in which there is a brave Christian prince and an equally brave but wicked Moslem potentate, a heroine who is captured or robbed or otherwise injured, soldiers of the Cross and warriors of the Crescent, and any amount of fighting, bloodshed and massacre.

The heroine is always rescued, the Christian prince always wins, and the luckless follower of Mohammed is consigned to defeat, disgrace and death. These Moro-moros last from two to six days, and produce so much excitement that when a good company comes to a village, nearly all labor is suspended until its departure.

Most of the plays are based upon historical incidents, more especially those in the long wars between the Spaniards of Luzon and the Visayas on the one side and the Islamites of Sulu on the other. It is only within the present generation that Sulu piracy has been destroyed. In the coast villages of Luzon, Panay, Cebu and Negros are living hundreds, if not thousands, who have seen the Moslem prahus scour the coast and descend upon many a village and town. In these wars the Tagals and Visayas fought shoulder to shoulder with the Spaniards against the merciless sea-rovers; and the prejudice respecting the latter is as strong to-day in the Filipino as it was in the troublous times of the last century.

Of the Tagals who have made their mark in the Spanish language, the number is small. The fault lies with the lack of opportunity. Journalism and literature in the Philippines are not in a very thriving condition. The entire output of printed matter in the archipelago during a twelvemonth would not equal a single day's issue of a leading New York daily. Illiteracy is universal, and the number of those who can read and write and afford to buy a book, outside of the foreigners, is probably not more than twenty-five thousand. Under the Spanish law nothing was permitted to be published which was objectionable to either Church or State. Anything coming under the former category made the author and publisher guilty of blasphemy and heresy, and under the latter of sedition and revolution.

The greatest native, Dr. José Rizal, was shot like a common murderer because he was found guilty of blasphemy and sedition; yet all that he did in his famous monograph was to recommend reforms in the ecclesiastical organization and the civil administration of the islands. In consequence of the cruel laws against the expression of opinion, what little writing has been done has been largely anonymous or impersonal. Thus Don Emilio Aguinaldo y Faury became famous through a clever skit said to have been inspired by Aristophanes' immortal play.

In it the characters, Spanish, native and half breed, are represented by animals, those being selected which best represent the qualities of the human beings for whom they stand. Aguinaldo was a contributor to the press of Manila and Hong Kong when the writer was in the Far East, and was a warm friend of the late R. Frazer Smith of The Hong Kong Telegraph. He has a fair education, having studied at one of the religious colleges in Manila. His writing is generally clever, always ornate and labored, and at times quite classical from a Spanish point of view.

An abler Tagal writer is Maguinor G. Sandigo, whose strong and brave utterances caused him to be denounced to the authorities. He was arrested, but through the corruption of the jail officials and the police he made his escape. He spent the most of this period in Singapore and Hong Kong, where he mastered English and prospered in trade. He has a deep love for English and American institutions, is the leader of the present annexation party, and is respected even by the Spaniards for his uprightness, public spirit and patriotism.

His writings began with newspaper letters, and when he was excluded by the press censors, he became a pamphleteer. Under the Spanish law his works, like all condemned publications, are seized and destroyed by the police wherever they may be found. It is therefore difficult to obtain his writings in the Philippines. They are to be had in Hong Kong, Singapore and other cities under English rule.

Two other men of some ability are Aserio and Agoncillo, both of whom are well trained, intelligent men of the world. They are not the equals of either Aguinaldo or Sandigo, but they are, nevertheless, far above mediocrity.

It is to be hoped that Dr. Rizal's works will be collected ere it is too late to bring the scattered fragments together. He was a graduate of a Manila college, where he distinguished himself in rhetoric, oratory and debate. He went to Europe and studied in both Spain and Germany, acquitting himself highly in both countries. He was a master of several Philippine languages, as well as of Tagal and Spanish, his native tongues. He was familiar with English, French and German, Latin and Greek, and had a good working knowledge of Chinese. He was capable as a physician, surgeon and oculist. Imbued with a deep love for literature, he wrote freely and well upon all sorts of topics. He contributed to the press of Manila, Hong Kong, Singapore and Madrid, writing letters of travel and studies of places, men and events. His favorite recreation was poetry, and many of his verses are recited in Spanish lands to-day by people who know not that their author was the famous rebel or patriot. In 1885 he published a novel, "Noli Me Tangere."

In 1887 and 1888 he published a series of articles upon Philippine life and conditions, which ran the rounds of the Far Eastern press. In 1890 he finished his famous monograph upon ecclesiastical and administrative reform, which cost him his life. He was executed in the prison-yard of the walled city of Manila on December 6, 1896. The day of his execution he married and wrote a poem. His wife and widow was of Anglo-Saxon blood and Hong Kong birth. This poem, entitled "My Last Thought," consists of fourteen five-line stanzas of considerable beauty, which has been well translated by Signor Volpicelli. It is unnecessary to quote the poem in its entirety, a few verses being sufficient to show Rizal's mode of thought and expression.

Farewell, adored Fatherland! Our Eden lost, farewell!
    Farewell, O sun's loved region, pearl of the eastern sea!
Gladly I die for thy dear sake; for yea, thou knowest well
Were my sad life more radiant far than mortal tongue could tell,
    Yet would I give it gladly, joyously for thee.

On blood-stained fields of battle fast-locked in maddening strife,
    Thy dying sons have blessed thee untouched by doubt or fear.
No matter wreaths of laurel; no matter where our life
Ebbs out on scaffold or in war or under torturous knife,
    We welcome death if for our hearths or for our country dear.

I die while dawn's rich iris hues are staining yet the sky,
    Heralds of that freer day still hidden from our view
Behind the night's dark mantle. And should the morning nigh
Need crimson, shed my heart's blood quickly, freely, let it dye
    The new-born light with glory of its ensanguined hue.

—The Independent.

ETHNOGRAPHICAL COLLECTIONS IN GERMANY.

THE question of the representation of primitive culture in our national museums is rapidly becoming an urgent one, not only on account of the growing importance of anthropology, but also because primitive culture itself is disappearing before civilization. The wild man is dying out or being transformed and the hours during which we may question him about himself are already limited. Those nations, therefore, which take the utmost advantage of the opportunities which remain will have something in the nature of a monopoly when primitive culture is actually extinct; and it is to them that the students of the twentieth century will have to apply for their facts.

If her present rate of progress is maintained, Germany will soon have so far distanced all other European countries as to place herself in a position of permanent and unassailable superiority. It cannot therefore but be a matter of importance to cast a glance at the present state of ethnographical museums in Germany, in order that we may form some notion of the relative position of our own.

Almost all the large cities in the German empire possess ethnographical collections, and in such places as Leipzig, Dresden, and Hamburg, these are of first rate importance. But none of them are in the same class with Berlin, and as it is with Berlin that London ought to measure itself, these short remarks must practically be confined to the German capital.

The Königliches Museum für Völkerkunder is a large building completely devoted to ethnographical and prehistorical collections; it has three floors, the lowest devoted to prehistory; the first to the collections from Africa, Oceania, and America; the second to those from Asia. For administrative purposes it is divided into five departments: the Prehistoric, the African and Oceanic, the American, the Indian, and the Chino-Japanese. Each of these departments has a keeper, who usually has two assistants under him, so that the scientific staff amounts to about twelve men. The museum has an annual grant of 50,000 marks, which is supplemented upon special occasions by the voluntary gifts of a committee of wealthy and patriotic citizens known as the "Hilfskomitée." The value of this unofficial assistance can hardly be overestimated. It makes possible the acquisition of exceptionally fine collections when the government grant is not alone sufficient, as in the case of Benin, and it provides the means of retaining scientific explorers and collectors in outlying parts of the world. The museum can thus command the services of well instructed investigators, and is in a position to carry out the work of collecting in a systematic and continuous manner. Berlin is probably far less dependent on the dealer and the unscientific collector than we are in London. Altogether

the Hilfskomitée appears to be a most admirable institution, reflecting the greatest possible credit upon all concerned.

The housing of the collections at the Museum für Völkerkunde is also excellent. In addition to extensive basements and a domed hall with a gallery running round it, there are two large and four smaller rooms on each of the three floors. Most of these are lighted from both sides, the objects being exhibited in large free standing metal cases with glass shelves, so that none of the specimens lie in deep shadow. The wall space between the windows and at the ends of the rooms is thus available for maps and diagrams, of which there are great numbers; there is also room for numerous "mannikins," or life sized models of representatives of various tribes, all carefully colored, and dressed and armed in the style of their respective countries. These figures, with excellent models of houses, canoes, and other large objects, and with ample and carefully written labels, afford a far more vivid picture of primitive life than can be obtained from books alone. The arrangement of the collections is geographical, but occasionally comparative series, known as "Vergleichende Gruppen," are exhibited; this is especially the case in the Indian section. A library and a lecture theater are important adjuncts to the building, and the latter brings the museum into direct connection with anthropological teaching. This has obvious advantages, for it probably enables the staff to stimulate the interest in ethnology of many students who afterward become connected with colonial administration.

Enough has perhaps been said to illustrate the advantages which Germany enjoys in the acquisition of ethnographical collections and in the dissemination of ethnological knowledge. Compared with our own, her position is very striking. We have no independent ethnographical museum, for at present we can only use for the purpose a section of the Department of British and mediæval antiquities at the British Museum. The officials of this department, with so many other claims upon their attention, cannot be expected to compete with the organized staff at Berlin, who concentrate their whole attention on ethnographical studies. Against continuous and systematic collection we can only set occasional and limited acquisitions. Under such conditions, the race between Great Britain and Germany is a race between Argus and a blind man. Nor can we flatter ourselves that we are to be eclipsed by Berlin alone, for Leipzig is already a serious rival, and Dresden is considering the erection of a new museum of ethnography. In numerous other towns there are abundant signs of activity.

If it is asked how it is that the Germans have outstripped us in this manner, several reasons at once suggest themselves. To begin with, the rapid commercial and colonial expansion of Germany during the last thirty years has been the expansion of the best educated people in Europe. Thus there has been little tendency to regard savage races from the point of view of a popular show, and a widespread capacity to assign to primitive culture its due scientific importance. If this is the attitude of the people as a whole, it is but natural that in officials, travelers and merchants a taste for ethnology is easily awakened. And as these are the classes in which a museum would naturally find its most useful allies, the national collections have greatly benefited by their interest and co-operation. The introduction to the Guide to the Museum für Völkerkunde contains a large proportion of official names in its long list of donors. Naval and military officers, consuls, doctors and administrators, are all conspicuous in their turn. The museum has also enjoyed the support of more exalted personages, for the German Emperors have all given proof of their sympathy upon various occasions. Again, the German museums appear in many respects to be worked more economically than our own. Their hours of closing are early, so that artificial lighting is not required in the galleries; they are also closed during at least one day in each week, which enables scientific studies to be carried on with the minimum of interruption, and the work of cleaning to be executed by a smaller staff. The fittings are also arranged with less regard for high finish than for practical and serviceable qualities. Finally, the wonderful energy and initiative of the veteran Prof. Bastian must not be forgotten. He has pressed the claims of ethnography with untiring enthusiasm for many years, and has had the reward of living to see the museum which he directs take the first place among the ethnographical museums of the world.

Comparisons are proverbially odious, and that which one is compelled to draw between Berlin and London is not gratifying to national pride. It is hard to believe that we can continue satisfied with present conditions, and sooner or later a change must come. Let all scientific men, whether their immediate interests lie in the direction of ethnography or not, lend their sympathy and support to any movement which promises to introduce a new order of things. But the old order must be changed quickly, or it may be too late. Even now it is doubtful whether we can ever make up all the ground which has been lost, for in some parts of the world specimens of primitive art are vanishing with such rapidity that complete collections are, perhaps, unattainable. But a serious effort made at the present time would be crowned at least with a comparative success; and the first thing to be done is to house in a more satisfactory manner what we already possess. It would surely be desirable to unite under one roof the collections which illustrate primitive culture, and those which illustrate the physical characteristics of the different branches of mankind. Meanwhile it should be freely admitted that we have much to learn from Continental nations, for not only Germany but also Holland can give us useful lessons in the ethnographical exploitation of a colonial empire. But Berlin is the model which we should set before our eyes: the frank admission of this fact will be the best preliminary to a more satisfactory state of affairs.—Nature.

According to Mr. W. de Fonvielle, the production of liquid hydrogen on any large scale may offer a ready means of manufacturing vacuum electric lamps. If a tube containing air is dipped in liquid hydrogen, the air is all frozen and condenses as snow; then if the lower part of the tube be separated from the upper by means of a blowpipe flame, the bulb so formed presents a Crooks vacuum.

THE POISONS OF THE EIGHTEENTH CENTURY.*

EVERY medallion has its reverse. It has been well said that the epocha of the efflorescence of the Italian renaissance was also that of "the Borgia," and of the carnival of poisons and poisonings, and that the mere mention of the name of Borgia evokes legendary souvenirs, which have been skillfully worked into prose and poetry by dramatists and romancers who have therein found an inexhaustible mine of literary resources, to the neglect of the era which immediately followed it, the reign of Louis XIV., but more especially the period included in the decennium between 1672 and 1682, when Brinvilliers and her adepts, Voison, Chéron, etc., encouraged by immunity, converted the court of Versailles into a new Rome, and spread abroad a horror and dread hitherto unknown in France—that of poison.

Louis XIV. decided, when too late, to act with severity. A special tribunal—the Chambre ardente—was created by his orders, empowered to deal solely with this band of assassins for pay, and the records of this tribunal are in existence to-day, preserved in the library of the arsenal. A study of these records, which embrace the confessions of the accused, and reports of experts, enable us to state with positiveness the nature of the famous poisons, and how they were manufactured by the alchemists of the day, unworthy successors of Nicholas Flamel. To simplify the study, we will divide it into three sections, accordingly as the poisons were of mineral, vegetable or animal origin.

MINERAL POISONS.

In the list of minerals, the first position must be assigned to arsenic, which, according to the picturesque expressions of the accused, is "the king and father of poisons." It was the weapon of these criminals, de choix et par excellence, and we can well understand their preference for it when we reflect that the physicians and pharmacists of that day, and for 150 years after it (there were no chemists as yet), were ignorant of the methods of searching for or identifying it, as well as of the symptoms and lesions caused by its ingestion. Moreover, its sale had not then been interdicted and it was as easily, though not quite so cheaply, procured as "rough on rats," or a box of blacking, is to-day.

It was, strange to say, rarely used pure (or "straight," as we would say in America), for which its tastelessness, inodorousness, and lack of color so eminently qualify it, and the ease with which it could be dropped into a drink or mixed with an article of food without detection, would seem to have been certain to have suggested itself.†

The substance—arsenic—was generally administered under other forms. It is, in fact, a phenomenon well known to those who have made a study of criminal anthropology, that criminals rarely avail themselves of simple processes, invariably making use of complex combinations, under the impression that in this way suspicions of the victims are more easily diverted or justice more certainly thwarted. Take, for instance, the formula or recipe of "the frog," one of those of this period, which is as follows:

Take a frog or toad, fill it with arsenic, and when it dies, desiccate the cadaver carefully. When dry, powder and preserve. Another process makes use of the results of putrefaction of a frog well dosed with arsenic.‡ "These," says one of the authorities of the day, "make an excellent poison, easy to administer and sure in action." We can well believe it. We may remark that this is a variant of one of the favorite processes of the Borgia. She, and the Italian poisoners generally, used a pig instead of a frog.

Whether obtained from pig or frog, however, this bizarre product was most certainly efficacious, and, at the same time, was most efficiently certain. Besides the deadly arsenic, there were the alkaloids of putrefaction, the ptomaines, etc., which combine directly with metals or metalloids introduced into the system, and the compounds thus obtained (amines) form definite and stable bodies, the toxic properties of which are greater than have been hitherto accorded them.

The amine formed by arsenic, under the circumstances, was first isolated in 1872 by Prof. Selmi, who gave it the name of arsine. It was obtained from the cadaver of a dog poisoned with arsenic. It was volatile, and had a powerfully toxic (tetanizing) action. The properties of the substance are, however, still but slightly known. In order to study it properly it should be prepared exactly after the formula of the Borgia, and then fix its toxicological coefficient by modern methods.

In default of exact experimental information, in the meantime we can form some approximately correct ideas by recalling two processes nearly analogous—the first of which is poisoning by arsenic mixed with fatty bodies. In cases of this description intoxication is retarded, and, besides this, the classic symptoms thereof may be entirely absent. "Death, under the circumstances," says Chapuis, "may be sudden, and accompanied with nervous phenomena altogether unexpected, and which nothing, from our previous acquaintance with arsenic intoxication, would have prepared us to expect." Here, then, are facts which recall the tetanic properties of arsine as isolated by Selmi. In order to obtain this preparation of arsenic according to the Borgia formula, nothing more is necessary than to open the stomach of a pig, sprinkle it with powdered arsenic, and gather the liquids which form during the process of decomposition.

We may, on the other hand, closely approximate the intoxication of the arsines by the phenomena produced by a gas whose relation thereto is sufficiently obvious—hydrogen arsenite (or "arseniureted hydrogen" of the older writers). We know the affinity existing between the hydrogen compounds of bodies like phosphorus, arsenic, etc., and their organic combinations,§ and we believe that we are in condition to institute a comparison between intoxication by hydrogen arsenite and one provoked by the arsines. We are well acquainted with the phenomena of the first. Everyone knows the minutiæ of the death of Gehlen, the Swedish savant, who succumbed from inhaling a few inspirations of hydrogen arsenite—a fact that proves the intensity of its toxicity. Says Lucas (Thèse de Paris, 1895): "We can assert with certainty that one single inspiration, made at the level of and in close proximity to a tube disengaging arseniureted hydrogen, endangers the life of one who makes it. If not fatal, it will produce exceedingly grave results." The symptoms of poisoning by this agent are peculiar, and at once tell the story. The kidneys are affected, and the patient dies of anuria in the midst of phenomena which recall those of no other form of poisoning, except of course those of arsenious acid.

By these prolegomena one can form a correct idea of intoxication by the arsines, that practiced by the Borgia and other professional poisoners of the seventeenth century, and we thus discover that the special and peculiar properties of substances, isolated within the past thirty years only, were well known to the empirics of the sixteenth century. We may say, in fact, that the latter had found the means of exalting the virulence of their favorite poison, arsenic, by causing it to pass through a living organism—just as we of to-day obtain a varying unit of toxic virulence by passing this or that microbian culture through this or that organism.

This process, so curious, so original, appears to have made many victims during the seventeenth century. It was probably, with slight variation perhaps, the poison of Brinvilliers and possibly of Fouquet, the Superintendent of Finance, memorable for his misfortunes, without a doubt well merited. We may add, too, that the deadly drug—that "poudre de succession," as it was called—was prepared by the greatest chemist of the times, the celebrated Glazer. After the execution of Brinvilliers, the formula was used by Voisin, Cheron, la Bosse, and a good many others.

The different processes of mixing the poison with articles of food or drink were very inconvenient—in one respect, at least. Poisonings and the rumors of poisoning had excited the suspicions of troublesome husbands, or lords grown too powerful (who were the usual victims), and they had become exceedingly distrustful of their food and drink, and began to insist on every article being tasted or partaken of by the servants or others, who brought in their dishes, and their wives, etc.—a custom that exists even to-day in certain quarters. It is a well known fact that the late Pope Pius IX., for thirty years before his death (commencing immediately after his election to the pontificate), tasted no food until a portion of it had been eaten in his presence by some one of his entourage.

At this juncture began that subtle and horrible method of making away with those obnoxious to the poisoners or their employers, the impregnation of the clothing, the handkerchiefs, the linen, and vestments of the victims—a method, we are well aware, usually regarded as legendary or mythical, but, nevertheless, true. It is, however, very easy to mix the false and imaginary with facts in the investigation of this uncanny subject, and especially in the study of the records of the "Chambre ardente."

"The poisoned shirt," says one of the witnesses, herself an accusée, "presented no extraordinary appearance. It was slightly rumpled, and looked as though badly laundered, possibly a little stiffer (plus ferme) than ordinary. When she showed it to him (her accomplice) she told him that nothing had been done to the body of the shirt, that only the tail had been prepared, and that the effect would be no more than to cause an eruption or inflammation, with great pains and dolors behind, and to the neighboring parts of M. Poulaillon, and when he was examined nothing extraordinary would be found." The "eruption" was diagnosed that of syphilis, and mercury was prescribed by the physician. It or some other drug was given, the trick was played (le tour ete joue) and M. Poulaillon slept with his fathers. Here was a crime admirably conceived and scientifically carried out.

How was this famous shirt prepared? Soaking it in an arsenical solution would not suffice, and we surmise that it was well rubbed with an arsenical soap similar to that used by naturalists to-day, for preserving the skins of birds and animals. This vehicle affords the only means of concentrating sufficient poison in the tissue of the linen to produce the effect related. Some experiments made by the writer, using arsenical unguents on the skin of a guinea pig, gave, it is true, negative results (this I ought scarcely to say, as the animal died of arsenical poisoning, but the poison produced none of its characteristic effects, so far as eruptions go). The animal was so fixed that it could not lick itself, and the intoxication must have been due, of course, to absorption through the skin. We may add, meanwhile, that the device resorted to by the poisoners produced its effects under entirely different directions. The shirt should and did have much more efficacious results, thanks to the continuous rubbing against the skin on parts so sensitive as the inside of the thighs, and the scrotum. "The linen," says the proces verbal, "was nearly empese," a condition sufficient, of itself, to provoke irritation, and even an ulceration of the epidermis. The denudation of the scarfskin by this agency might well have been sufficient for the arsenical soap to produce the pseudo-syphilitic eruption.

We must not, however, confound this experimental intoxication by means of a poisoned shirt with the legendary poisonous gloves, mantles, and flowers of the novelists. Louis XIV., it is said, narrowly missed falling a victim to an attempt of this nature. The "Chambre ardente" either could not, or did not, care to go into this attempt, in which Madam Montespan was involved. On the contrary, however, it appears almost certain that the Duke of Savoy died from poison administered by means of a poisoned shirt (as may be seen by reference to the proces verbal of the "Chambre ardente").

Such were the methods of utilizing the mineral poisons, arsenic, sublimate,* verdigris and antimony. Arsenic was the poison, however, generally used, and

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* Compiled from original sources, principally manuscripts of the period, found in the Bibliotheque de l'Arsenal, Paris, by Dr. Ducien Nass, in the Gazette des Hopitaux. Translated expressly for The National Druggist.

† See the "Poisoning of the Marquis de Brinvilliers" (Manuscript Pirot, National Library); the "History of the Villequey Tart" (Plumalep de la Tourtelle. National Library), etc.

‡ The only objection that we can see to this is the fact that a frog "well dosed with arsenic" will not putrefy.—Trans.

§ Chapuis found in the urine of an animal poisoned with an arsine, a substance which disengaged hydrogen arsenite.

* Corrosive sublimate was, according to the story, the poison administered by criminal hands to Henrietta of England, sister-in-law to Louis XIV. Littre, and after him, Prof. Brouardel and M. Frantz Funk-Brentano, have done justice to this legend, which, in the meantime, finds an ardent defender in Dr. Legue (Memories of Poisoners of the Seventeenth Century)

for the reasons made plain by us in the foregoing statements.

In the meantime, there was another method by which the acids were employed. They were introduced into the organism by the rectum. All students of medical and pharmaceutical history knew the use, or, rather, the abuse, of the clyster at the period of which we write, or the seventeenth century, almost in its entirety. Nothing was easier, with an apothecaire facile,* as an accomplice, than to drop into the clyster a little "eau forte," or aqua fortis, and the deed was done. An ulceration of the great gut was first provoked, and this was followed by perforation, mortification and death. The author has, in a former treatise (Thèse de Nass, 1898), detailed experiments which go to prove this hypothesis. However it may be, we have found in these proces-verbaux abundant examples pointing to acid poisonings made in this manner. The number of vegetable poisons employed at this period was also very considerable. In fact, we are justified in saying that there is scarcely a herb or vegetable enjoying toxic repute that was not called upon to justify its reputation in this direction by the insatiable poisoners and dealers of secret death. The poppy held first rank, and with it the other stupefying agents, stramonium, mandragora, etc. Generally these drugs were associated together in the same potion. The effect was more or less certain, for we know to-day that these "magic" drugs of the seventeenth century (especially mandragora) are recognized as being more or less uncertain in action; and variable in effects. Meanwhile, our documents show, for certain, that mothers poisoned their infants with opium, finding out how sensitive the innocents are to that medicament. Besides this, it seems that this drug, in the hands of criminals, was used as a favorite method of facilitating robbery at this period. (See Revaisson, Archives de la Bastile, vols. iv-viii.)

After the opiates and hypnotics generally came the drastic poisons—aloes, spurge, pignon blanc, etc., besides certain plants reputed very dangerous, either rightfully or wrongfully — the morelle cigne, etc. Finally, according to the confession of one of the accused, certain exotic products were used. One celebrated female poisoner ordered from America some bitter manioc, very poisonous when it is not prepared, and poisoned arrows. We may see from this that the matrons had at their disposal the greatest variety of poisons, from those well known to everybody to the rarest and least known, even by experts, at that period. Who knows but that curari had its victims in those days?†

There remains still to be noticed poisons of animal origin, of which there were but few of importance then known, cantharides being the exception, and their use was very extensive, in spite of the stern interdiction of their sale and the severe punishments following conviction. Their sale was interdicted even to apothecaries and physicians, but those bluish flies were to be obtained of every professional abortionist, midwife, and poisoner, and were used less as poisons than as aphrodisiacs. Their reputation in this direction obtains, and with good reasons, even to-day, and we are of the opinion that their use was confined to philters, love potions, etc., at the time. For all this, however, fatal intoxications from this source, generally accidental, but sometimes with intention, were of frequent occurrence. For information on this point, see the works of Ambroise Paré, book xxi. passim.

Such are, in brief, the favorite poisons of the seventeenth century, but alongside of them there is a series of pseudo-poisons, the enumeration of which would occupy too much space for our present purposes. They constitute an extraordinary and bizarre list, to which magic or sorcery alone lent any toxic virtues. An examination, however, of the genuine poisons, known and in commerce at this epoch, shows that arsenic, in its various forms, did not constitute the whole series, the pièce de resistance, as has been persistently claimed, hitherto, by historians and toxicologians. That it was, probably, the deadly agent most resorted to, and for good reasons, is admitted; but it would be a great piece of folly to imagine that it constituted the sole agent of intoxication used by the murderers and murderesses of this age, or of the preceding one, of the Borgia and her imitators.

The most remarkable thing about the whole horrible affair is the extraordinary cunning displayed by these criminals. They rarely employed a simple substance. By their processes, more or less skillful, they sometimes, it is true, obtained less satisfactory results than if they had used a simple solution, or tea, but sometimes, as precursors of veritable chemists, they displayed an intuition by means of which they anticipated modern discoveries. They investigated the alkaloids in distilling, maladroitly, it is true, the "vegetable"‡ of plants. They employed the amines by uniting the metals or the metalloids with organic bases or acids. Crime was here two centuries in advance of science, a fact of which science should make note.

All the apparatus in the Guest closed conduit system is contained in a 4-inch by 3-inch channel iron, laid as a continuous central conduit. The cover to this conduit is bolted on in sections, insulated from the conduit and from each other, and carries all the working parts. Iron induction plugs are secured at frequent intervals in the cover, from which they are magnetically insulated. The only electromagnet is carried on the car, is energized by the motor current or by cells, and operates, by induction through the plugs, on a pendulous armature which connects the section of cover plate onto the feeder. A few series-turns round the plugs insure firm contact when once the cover-plate is alive. When the car and its magnet move on, the pendulous armature drops and breaks contact between feeder and cover-plate.

* Apothecaire facile, or anglicized, an accommodating apothecary; the readiness with which the members of the profession loaned themselves to the horrible crimes of the period of which the author writes, is in no small degree responsible for the traditional hatred and distrust of the apothecary that exists even to-day, among the less intelligent public, and displayed in the secular press. It is the old Aesopian story—give a dog a bad name, etc.—Trans.

† Strange to say, our erudite author fails to mention one class of vegetable poisons said to have been much in vogue at that period—the agarics, mushroom, etc. The false orange-agaric, one of the most deadly of the tribe, is said to have played a part in the taking off of several prominent men of the period.—Trans.

‡ Under this term was understood the proximate principle of plants, as we now term it.

AN ADVANCE IN MEASURING AND PHOTOGRAPHING SOUNDS.*

By Prof. BENJAMIN F. SHARPE, M.A.

THE NATURE OF THE PROBLEM.

SINCE the passage of sound through the air consists in alternate condensations and rarefactions, a direct measurement of the intensity of sound must measure these changes in atmospheric pressure. Practically this has been very difficult to do for two reasons: first, because these pulsations follow each other so rapidly. Middle C on the piano, for instance, has 256 condensations, each followed by a rarefaction, making 512 distinct pressure maxima and minima in a single second; evidently no ordinary instrument for measuring pressure, such as the barometer, would serve in this case. But the second and greater difficulty lies in the fact that these condensations are so exceedingly minute, being indeed from a hundred thousand to a million

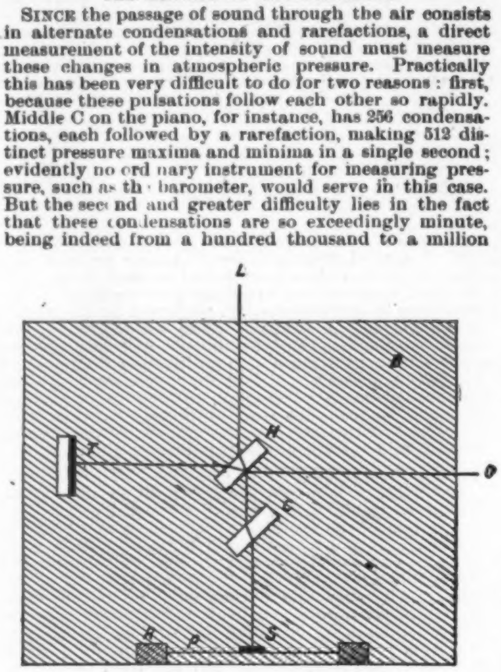


FIG. 1.—Plan of the Refractometer.

times smaller than the pressure differences that can be read on an excellent mercurial barometer.

Consequently the energy acting upon the ear drum in case of the faintest audible sound is of the same order of magnitude as the energy falling upon the retina from the faintest star visible to the naked eye, a star of the sixth magnitude; while the energy of a sound of maximum intensity (at this point the ear ceases to distinguish which of two tones is the louder) is about as much as that involved in the growth of a single ordinary blade of grass in June. So in every case we are dealing with very minute quantities of energy.†

There are a great variety of sounds to be measured, but for convenience we may group them all into three great classes: noises, musical notes, and pure tones. Of these, pure tones are the simplest, for they consist of a definite number of pulsations per second, and the pulsations follow each other at equal intervals. A tuning fork affords a good example. If it be struck gently it produces a faint tone, if it be struck harder a louder tone is heard, but the sound does not change in character or in pitch; only the intensity of the tone changes. If we wish to change the pitch, a fork of different dimensions must be taken. Consequently there are two measurements to be made in studying even the simplest sound, viz., loudness or intensity and pitch or frequency, the latter being the number of pulsations per second. A musical note is some combination of pure tones, whose frequencies bear a simple ratio. But the choice of the component tones, as well as their relative intensities, determines the differences in quality or timbre, such, e. g., as the difference observed between the same note produced on the flute and on the violin. A musical note, accordingly, has

FIG. 2.—The Refractometer.

to be analyzed into its component tones before the note is fully determined. We might naturally suppose that a further distinction might be made based on the differences of phase arrangement possible in a note, but it is found that the ear does not appreciate these differences, though the photographic instrument herein described makes them evident to the eye. If now we add to a note a single tone whose frequency does not bear a simple ratio to the other component tones of the note, a discordant sound or noise results. And even though a particular noise contained a hundred tones and not a single simple ratio, its complete determination would involve nothing more than the determination of the frequencies and intensities of all the component tones at the given instant. Of course these components may be continually changing from moment to moment. In fact, noises are hardly ever constant in either loudness or quality, and this fact, together with the very great variety of frequencies, which the component tones may have, renders it so difficult to completely determine a noise, that as yet this has never been done. But our instrument will photograph a noise as well as any other sound, and by the aid of the photograph we may determine its principal component tones, and also the intensity of the noise.

AN INSTRUMENT TO MEASURE SOUND.

We would naturally begin with the simplest case in working toward a sound measuring instrument, and fortunately this is also the case of the greatest physical importance, since all the theoretical laws concerning

FIG. 3.—Strip of Interference Bands.

the propagation of sound assume a pure tone. To test these laws, or rather to derive them experimentally, we do precisely as we would in any scientific investigation, i. e., eliminate unnecessary complications, in this case by dealing with a pure tone.

A pure tone of medium pitch may be magnified forty or fifty times by receiving it in a Helmholtz resonator. This is nothing but a hollow sphere of some hard substance like brass or glass, having a hole for the tone to enter, and a small, funnel-like projection to place in the ear. Within this resonator the condensations and rarefactions may be fifty times greater than in the open air. But any cavity magnifies, though not so much, some one tone to which it resounds. A "Mellin's Food" bottle, for instance, is a resonator to a note a trifle below middle C. When its open mouth is held near the ear and its note is sung, the bottle is heard to resound very strongly. So we have taken one step toward overcoming the twofold difficulty by magnifying the infinitesimal pressures of sound by means of a resonator, carefully constructed,* to resound to the tone which we propose to measure. Another step is taken by causing these magnified pressures to act upon a very sensitive plate.

Here is the same principle as that involved in the telephone and phonograph. The pulsations of the air within the resonator force the plate to vibrate in close imitation; for the thin plate is made to form a part of the walls of the resonator, by cutting out a circular hole in the resonator opposite its mouth, mounting a ring on this circle, and attaching the plate to the ring. We make this step as long as possible by so choosing the substance and dimensions of this plate,† that its own fundamental tone when mounted is identically that of the tone to be measured. Here again we invoke the aid of the principle of resonance, which is a very powerful and far-reaching principle. In this instance we obtain no further magnification of the sound motion, but we gain this great advantage, that instead of the infinitesimal motions of invisible particles of air, we have now a measurable motion of the center of a definite plate of solid substance.

FIG. 4.—Object Glass of the Telescope, showing heavy frame, electro-magnet, mercury connection, and rubber supports.

Therefore we next require some optical device for observing this motion. Prof. A. A. Michelson's form of the refractometer‡ is admirably suited to our purpose. It consists of a system of mirrors by which one beam of light is separated into two beams; these travel paths differing slightly in length, so that, when they are reunited, the interference of the waves of light produces interference bands. The arrangement of the mirrors is shown in Fig. 1.

B is a metal base with horizontal surface. On this the mirrors are mounted with their reflecting planes perpendicular to the surface, *B*. A beam of light comes horizontally from a lamp in the direction of *L* and encounters the half-silvered mirror, *H*, so called because it has a very thin film of silver on its shaded side. Here the beam is separated into two; one part is transmitted through the silver film toward *S*, and

* From The Monthly Weather Review, published by the United States Weather Bureau. The work here described was done recently by the author, Prof. B. F. Sharpe, while a fellow in Clark University, following a suggestion made by Prof. Webster. A much more detailed, technical account of the apparatus and the associated mathematical theories will be published later. This general preliminary account has been prepared for The Monthly Weather Review at the request of the editor in the belief that the instruments and methods here given will prove serviceable in certain special meteorological investigations, since the faintest waves of pressure are recorded by the apparatus

There are many acoustic phenomena observed in the atmosphere whose analysis, with the help of proper apparatus, ought to give us methods of determining the velocity of any movement going on in the air, the temperature of the air, the disturbances produced by warm bodies, by the explosions that attend meteors, lightning, cannonading, etc., and especially those that attend the formation of rain, hail, and snow. It is not for the ordinary Weather Bureau observer to conduct these delicate investigations; they are the special province of the mathematical physicist and laboratory expert. To the latter meteorology must look for the further building up of this branch of our science. It is likely that the study of the vagaries of the sounds from fog signals, which has been prosecuted by our Lighthouse Board without the help of Prof. Sharpe's ingenious apparatus, would become more precise and satisfactory if his methods could be applied to that study. Meteorology has much to hope from the proper study of sound waves, which are, in fact, only minute waves of barometric pressure, and Prof. Sharpe's methods take up the subject where the ordinary barograph fails on account of its sluggishness.

† Wien, Uber die Messung der Tonstarke, Berlin, 1888, p. 47.

* Helmholtz, Sensations of Tone. Second English Edition, p. 373.

† Rayleigh, Theory of Sound, sec. 218.

‡ Michelson, "Interference Phenomena in a New Form of Refractometer." American Journal of Science, 1882 (3), xxiii., p. 395. See also the mathematical treatment by Prof. Michelson in Philosophical Magazine, January–June, 1882 (5), xiii., p. 236.

the other is reflected from the silver surface toward *T*. *T* is a totally reflecting mirror, its face is heavily silvered, and it is so set that the beam falling upon it from *H* is reflected back to *H* over the same path. This part of the beam penetrates the silver film of *H* and proceeds toward *O*. The other part also encounters a totally reflecting mirror at *S*, by which it is reflected back to *H* along the same path whence it came, and it is again reflected from the half-silvered mirror toward *O*. Thus, from *H* toward *O* the two beams travel the same path. But the beam going to *T* travels three times through the thickness of the glass, *H*, before arriving at *O*, while the other beam, that goes to *S*, passes through *H* only once. Consequently, there is a difference of path which would be troublesome if we did not equalize matters by introducing a compensating glass, *C*, of the same kind and thickness as *H*, and set parallel to *H*. If still there is a difference in path of an odd number of half-wave lengths between the

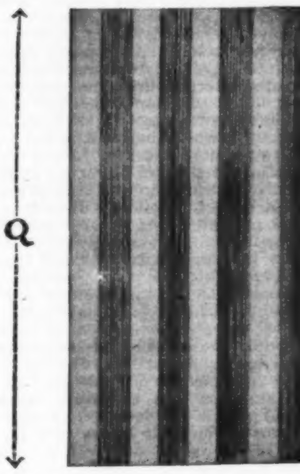


FIG. 5.—Strip of Bands Elongated by the Vibration of the Object Glass.

double distances, *HT* and *HS*, an observer in the direction, *O*, looking toward *T*, will detect interference bands. If the light coming from *L* is the yellow light of a sodium flame, these interference bands will be alternately black and yellow; their width, shape, and direction will depend upon the orientation of the reflecting plane of the mirror, *T* or *S*. If *S* has the direction of its plane fixed, small adjustments may be made in *T* by which we can arrange the bands to suit our purpose. Suppose we make them just wide enough so that the four black and four yellow fringes occupy the field of vision, in this case a surface equal to *S*; suppose we make the bands have straight edges and make them stand vertically in the field. If now we cause either *T* or *S* to move slowly parallel to itself, we find that a very small motion of the mirror causes a very large shifting of the bands to one side. In fact, a motion in *S* amounting to about 0·0003 mm. causes a pair of fringes to occupy the place of the next pair. Of course as much motion as this in the bands is perfectly evident to the naked eye, but by means of a telescope with micrometer eyepiece a motion in *S* of a hundredth part of that just named could be accurately measured, viz., three-millionths of a millimeter.

Here is an extremely sensitive instrument for meas-

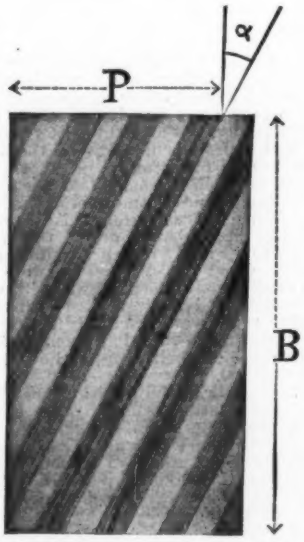


FIG. 6.—The Effect of the Vibrating Object Glass upon the Elongated Bands.

uring small displacements. We will apply it to our purpose by mounting a very small and light mirror on the center of our sensitive plate, and by bringing this mirror into the position of *S*, Fig. 1. The refractometer is shown in Fig. 2, uncovered and with its resonator removed. The little mirror is in place, and a ring, similar to the one on which the sensitive plate is mounted, lies in front. The resonator is mounted by screwing its ring into the same frame that supports the ring of the sensitive plate. A thin rubber ring serves as packing. If now the mouth of the resonator is corked, and the air within it is slightly compressed, the thin plate will bulge out a little, and the bands will be displaced, say to the right. But if the pressure within the resonator is slightly less than that without, the plate will bulge inward and the bands will be displaced to the left, there being always a fixed ratio between the pressures and the motion of the bands. In this case the pressures can be measured with a water manometer.

Just here we have to meet the second part of our twofold, fundamental difficulty in measuring sound, for the pressures we have to measure in the resonator, due to sound, are not steady pressures such as we have just obtained by means of the air pump, but they are very rapidly alternating pressures, and even though our thin plate with its little mirror follows them perfectly, yet the motion of the interference bands from side to side is far too rapid for the eye to follow. But we can make the displacement of the bands a measurable quantity by aid of the simple principle of the composition of motions. To do this we place a screen in the path of the interfering light,

FIG. 7.—Micrometer Eyepiece, rotating on its optical axis to measure angles, and provided with tangent screw.

as near to the half-silvered mirror as convenient. This screen has a narrow horizontal slit, so that the bands are cut down to a narrow strip. This viewed in the telescope appears as in the accompanying figure (Fig. 3) and has a vertical height, *o*, measured in micrometer divisions. If now the object glass of this telescope is a small light lens mounted on the end of a tuning fork (which is electrically driven and is in such a position that the lens vibrates in a vertical line), the thin strip of bands will appear greatly elongated, as in the accompanying figure (Fig. 5), for its vertical height has been stretched out by the changing refraction of the rays due to the motion of the lens, from *o* to *Q*. We have supposed thus far that no sound whatever disturbs the sensitive plate, but now we start a tone which has the same number of vibrations per second as the fork carrying the object glass. The vibrations of the little mirror, *S*, due to the tone, cause every point in the narrow strip to vibrate horizontally across the field, while the motion of the object glass causes every point to vibrate vertically at the same time. Consequently the composition of these two motions may result in an oblique line for each point, and the image of the bands may appear in the telescope as shown in Fig. 6. In this figure the displacement, *P*, due to sound, is three and a half double bands; and it is related to *a*, the slope of the bands, in such a way that $P = B \tan a$, in which $B = Q - o$.

A louder tone causes a wider displacement, *P*, and if the elements incidentally involved in the measurement remain constant, then the intensity of the tone will be proportional to P^2. This is equal to $B^2 \tan^2 a$; hence, what we actually measure are *o*, *Q*, *a*, and the width of a band; so that *P* is determined in wave lengths of light. The eyepiece is specially constructed to meas-

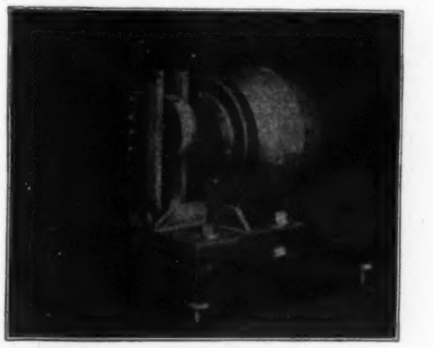


FIG. 8.—The Source of Tone with the Box Removed.

ure angles, as well as lines in any direction. The displacements, combined with a knowledge of the pressures within the resonator necessary to produce them, give the intensity of sound in an absolute measure, i. e., in ordinary units of energy, such as ergs or foot-pounds. More exactly, it may be stated, that the motion of the little mirror fixed on the sensitive plate is calibrated in terms of pressures within the resonator, by means of comparison with the motion of a second plate of high pitch on which a steady pressure acts. This is necessary, because the rhythmic pressure of a tone, well timed to the natural oscillations of the plate, produces far greater displacements than a steady pressure of the same amount; just as a horse in trotting may give a bridge so much motion as to endanger it, while the weight of the horse standing still would produce no apparent bending. But if the second plate is only four octaves higher in natural pitch than the tone measured, the pressure may be measured statically with an error of less than four parts in a thousand. The mathematical theory by which these observations are made to yield an absolute measure of the intensity of a sound is a modification of that employed by Wien* for a similar purpose.

INCIDENTAL DIFFICULTIES OVERCOME.

The two fundamental difficulties have now been entirely removed. We have magnified the sound pressures and the displacements which they produce in spots of light, until the former can be accurately measured by means of the latter. But meanwhile we have met three incidental difficulties, each so serious as to threaten us with defeat. One of these is a little matter of difference in phase. It is stated above that

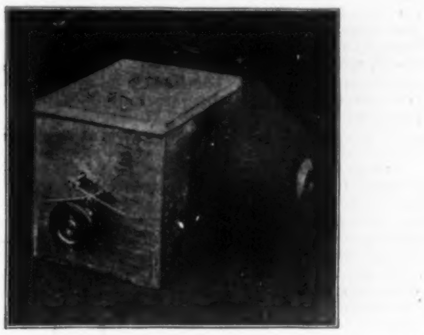


FIG. 9.—Refractometer, boxed and ready for use. The resonator is covered with felt. The screws and levers adjust the mirror, *T*.

the appearance of the image due to the double motion may be like that represented in Fig. 5. But as a matter of fact the probabilities are very largely against its so appearing. For the composition of the double motion of the light and dark spots of Fig. 3 into the straight lines of Fig. 5 is due to the fact that a spot begins its motion to the right, for example, at the same instant that it begins to move downward. This is agreement in phase, for both of these independent motions are harmonic, or pendular. So, if we see Fig. 5 in the telescope, it is because the source of sound is just far enough distant for a sound impulse to act upon the sensitive plate as the object glass is begin-

FIG. 10.—Welsbach Lamp, with metal globe to confine and concentrate the light.

ning one of its swings. But if the source of sound is moved a little from this position, the two motions will be out of phase; and accordingly each spot of the strip will describe an ellipse of eccentricity depending on the phase difference, just as in the familiar case of Lissajous' figures for forks in unison. Evidently a very small amount of eccentricity will make the ellipses overlap and blur the edges of the oblique bands so completely that we cannot set the spider line of our eyepiece to the slope of the bands. Of course, a motion in the source of sound of less than a wave length of the tone may bring the two vibrations into phase again. But in a room, where such investigations are usually carried on, the reflections of sound

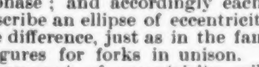


FIG. 11.—The image of the interference bands focused on the film, but greatly enlarged in the figure.

from ceiling, floor, and walls, cause an additional disturbance in the form of standing waves, and consequently we would have to move the source of sound about in the three directions while seeking the positions that would give agreement in phase. This is extremely laborious, and thoroughly unsatisfactory; moreover, it unduly limits the usefulness of the instrument. The phase of the object glass, on the other hand, may be varied by means of an adjustable self-induction (thrusting an iron core into a coil of wire in the circuit by which the tuning fork is driven) and in some other ways; but these variations are insufficient for all cases, and are therefore unsatisfactory. What we will do, then, is to make the tone and object glass

* Wiedemann Annalen, 1889, p. 835.

differ slightly in frequency, by putting a small load, e. g., of adhesive wax, on the tines of the fork carrying the object glass. In this way we make the phases of the one oscillation overtake those of the other as slowly as we please; then in the telescope we will observe the bands sloping downward to the left, as in Fig. 5, and after an interval of two or three minutes the bands will have the same slope downward to the right. Between these appearances confusion will reign, for during the interval the field is occupied by overlapping ellipses. But there is abundant time to make a careful measurement of the angle of slope at either extreme position, i. e., when the phases are identical, and when they are opposite. The angle in each case will be the same if only the tone is constant in intensity.

Another of these incidental difficulties was how to get a plate thin enough to be sensitive, homogeneous enough to vibrate in a symmetrical manner, and elastic enough to come to rest always in the same position. Ten substances were investigated without success, when finally the thinnest cover glass, for use with the microscope, was found to be satisfactory. Thus far glass has been employed as the most available substance for thin plates, though either steel, or gold of 14 karats, promises ultimately to prove superior.

AN INSTRUMENT TO PRODUCE PURE TONE.

A third incidental difficulty was a suitable source of sound, for we must produce our sounds as well as measure them. To investigate the fundamental laws of sound, it is important that our source produce a pure tone of very great constancy in pitch and in intensity. Besides, we must be able to vary its intensity at will between wide limits. Moreover, the source should afford a very definite point from which to measure its distance to the resonator of the refractometer. And, finally, the source should be very portable, so that this distance may be varied at will. No such instrument exists, so we must construct one. A tuning fork makes a good beginning, for it is very constant in pitch or frequency, and also tolerably pure in tone, its overtones being relatively weak. Moreover, the inertia of a heavy fork tends greatly to make its tone constant in intensity. But a fork alone will not serve our purpose, for at best we cannot make a very loud sound with it, its overtones are somewhat objectionable, and there is no one spot whence the sound originates. So we will select a place on the fork which has a simple vibration and transmit its motion to a thin iron plate. This is done by fastening one end of a wire to the middle of the fork, which is a node for the fork's overtones, and fastening the other end of the wire to the center of the plate. The direction of the wire is the same as that of the motion of the fork, and perpendicular to the plate, so that the center of the plate is forced to vibrate exactly as the middle of the fork. But the plate itself is likely to have some overtones, so we will filter these out and greatly intensify the pure tone by making the plate a portion of the walls of another Helmholtz resonator, made and tuned to resound to the very tone which we propose to measure, which will be also the tone of the fork connected with it. This arrangement makes a very pure and effective source of sound. Simply tapping the fork with the finger makes a pretty loud sound, and the mouth of the resonator affords a definite center from which to measure distances; when in use a heavy padded box covers this instrument, excepting the mouth of the resonator, so that the tone emerges from the mouth only. A constant tone is produced by driving the fork electrically by a constant current. The intensity of the tone will depend on the strength of the current, which we can regulate at will. Moreover, the intensity of the sound can be defined in terms of the current effective in producing it. In other words, the current can be calibrated in terms of the absolute intensities of the sound produced. This is done by means of the damping factors of the arrangement. The mathematical theory of this source of sound as an absolute measure is really only an extension of that given by Lord Rayleigh* for the tuning fork.

SOME USES FOR THESE INSTRUMENTS.

If we assume that the ear is constant and reliable, we may employ it instead of the refractometer arrangement in connection with our source of sound in many important investigations. For example, we may investigate the variation of intensity with distance under various atmospheric conditions. To do this we place our source in a smooth open field when the air is free from wind and noise, produce a tone of small intensity and gradually withdraw until it is just audible; then we increase the intensity and again withdraw until it is just audible. This is repeated several times until we have withdrawn to the verge of audibility of the loudest pure tone which our instrument produces. Then a comparison of the intensities of the tone, with the corresponding distances of audibility, will give the law that we seek. After such a law is established, the distance at which two different persons can detect the same tone will give a numerical measure of their sense of hearing; and similarly the hearing of the two ears of the same person can be compared by stopping carefully one ear at a time. Tests of the hearing of a person in various mental and physiological conditions, as also for sounds of different pitch, can be made. Moreover, the smallest change of intensity appreciable by the ear can be determined throughout a considerable range of initial intensities. By varying the intensity of the source, so that bare audibility is reached, we may likewise study problems of sound shadows, reflections, refractions, and (with two such sources, or a single source obstructed by a large building) interference. Thus our tone source may be of use both in the physiological and physical laboratories. By submerging this instrument in lake or sea, similar problems may be solved for water as the medium of sound. Of course we shall require one such instrument for every tone which we propose to use, though simply weighting the tuning fork gives a small range of frequency, sufficient to be appreciable as pitch.

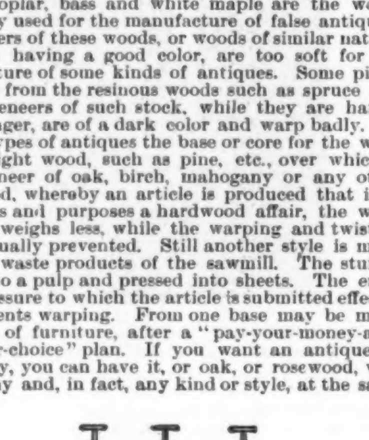
But if, instead of using the ear, we eliminate its imperfections by using our receiving and measuring apparatus, we may solve a very large number of acoustical problems with great precision. In addition to those mentioned we may suggest: the distribution of sound in a large room, as well as the natural pitch and echo of the room; the wave lengths of various tones; combinational and differential tones; the viscosity of the air; the energy of the faintest tone that is audible. Considerable pains must be taken to prevent disturbing sounds from affecting the action of the sensitive plate. These sounds are transmitted both through the air and through the floor and supports. In so far as they originate in our apparatus, we prevent them by employing tight, heavy boxes for coverings, and soft rubber piers for supports. Other sounds which come from the building or street cannot be avoided altogether, except by working in the middle of a calm night. But even the tone to be measured should not have access to the side of the sensitive plate which bears the little mirror. Consequently, the refractometer itself must be carefully boxed, so that only the mouth portion of the resonator protrudes; the refractometer also rests upon rubber piers.

(To be continued.)

* Phil. Mag., 1894, p. 365.

MAKING FALSE ANTIQUES.

The manufacture of false antiques has reached such proportions, says The New York Tribune, as to call forth a few remarks. First, a dusty, dingy shop is selected and a few pieces of genuine antique furniture are put in the show window, and operations in the manufacture of false antiques begin in the rear of the shop. Poplar, bass and white maple are the woods ordinarily used for the manufacture of false antiques; but veneers of these woods, or woods of similar nature, although having a good color, are too soft for the manufacture of some kinds of antiques. Some pieces are made from the resinous woods such as spruce and fir, but veneers of such stock, while they are harder and stronger, are of a dark color and warp badly. In several types of antiques the base or core for the work is some light wood, such as pine, etc., over which is laid a veneer of oak, birch, mahogany or any other hard wood, whereby an article is produced that is to all intents and purposes a hardwood affair, the wood of which weighs less, while the warping and twisting are effectually prevented. Still another style is made from the waste products of the sawmill. The stuff is reduced to a pulp and pressed into sheets. The enormous pressure to which the article is submitted effectually prevents warping. From one base may be made all kinds of furniture, after a "pay-your-money-and-take-your-choice" plan. If you want an antique in mahogany, you can have it, or oak, or rosewood, walnut, ebony and, in fact, any kind or style, at the same



APPARATUS FOR AGING FURNITURE.

price, all due to the new industry that seems to be of unlimited application and value to those who cannot afford to buy genuine antique furniture in the original form. It is possible to make artificial antiques from these stocks of wood and sell the goods for what they are. Many people want the old Egyptian types of furniture for ornamental purposes, and are often satisfied with a reproduction. If the reproduction is made like the original and sold as such, no harm is done, and the purchaser gets what he wants at a low price. The writer knows of one dealer who, owing to the difference in price, sells a dozen reproductions to one antique now, and he does it honestly.

In making honest reproductions the stock selected is first prepared for manufacture into furniture, ancient or modern. The whitewoods are dyed to the required shade by a device consisting of a boiler, to receive the charges of dye-stuffs, into which steam and water are admitted, and with a dye vat, where the wood is placed.

Golden brown is dyed on fifty pounds of whitewood as follows; 3 per cent. chrome (bichromate of potash) and 1½ per cent. tartar (bitartrate of potash).

The wood is entered at 160° F., the temperature of the dye bath is raised to the boiling point in thirty minutes and boiling is continued for one hour. Then the wood is dyed again as follows: 20 per cent. golden brown, 3 per cent. Glauber's salt (calcined sodium sulphate) and 2 per cent. copperas (ferrous sulphate).

Dark plum on one hundred pounds is effected with three pounds bichromate of potash, two pounds tartar, five pounds fustic liquor, one pound logwood liquor, five pounds alizarine violet and three pounds acetic acid.

Purple on seventy-five pounds is made in a bath containing 4 per cent. sulphuric acid, 10 per cent. Glauber's salt, ⅝ per cent. caromotrop and 3-16 per cent. cyanine.

Olive green on fifty pounds is colored in a bath containing 4 per cent. sulphuric acid, 10 per cent. Glauber's salt, $\frac{3}{16}$ per cent. cyanine, 1¼ per cent. Victoria yellow and $\frac{1}{16}$ per cent. chromotrop 2 R. The wood is put in at 140° F., the temperature slowly raised to a boil and boiled one hour.

Violet is colored on sixty pounds of wood with one pound of tannic acid and one pound tartar emetic. Rinse off and dry with four ounces rhoduline violet and one pound acetic acid. Enter the bath cold; bring the temperature up to lukewarm while turning, and turn to shade at that heat.

Alkali red on fifty pounds is made as follows: Start a bath by dissolving one-half pound alkali red in fifty gallons hot water with two gallons caustic soda lye, 60° Tw., 150 pounds salt. When dissolved, add enough water to make a hundred-gallon bath. Enter and run one-half hour at 180° F., and rinse well in cold water.

Terra cotton on one hundred pounds is colored as follows: Prepare a bath with four pounds oil of vitriol and ten pounds Glauber's salt. Enter at 130° F., bring the temperature up to a boil while turning, and turn to shade at that heat.

The finish is one of the important parts of the business, as it involves the aging of the articles. This is effected by means of alternate application of steam and hot air. The apparatus used is shown in the figure. The sides and back are brick, the top is sheet iron and the base wood. A second slatted bottom is provided upon which to stand the piece of furniture. A sheet iron door is bolted to the front and steam let into the distributing pipes, D, through pipe, B. C is a vent. After steaming for about twenty minutes, hot air is let in through A. Several applications of steam and hot air have the desired effect, after which the goods are ready for finish. This depends upon whether a stain or natural finish is wanted. To stop absorption the favorite materials are glue size, shellac and boiled linseed oil or "drying" oil. The first named of these materials is not always a good basis, the second is fairly satisfactory, while the third is good if the oil be pure, and is still more effective if there be added to it a fair proportion of zinc white, bringing its consistency up to that of a thin paint. There are also to be found in the market many "liquid fillers" and "primers" which are moderate in cost and generally serve well. After the finishing coats are put on, the article is placed to dry in a moderately heated room. After this is done it is put into the oven, where it receives a glazing. Incomplete drying, before the article is put in the oven, would beget blisters and bubbles. The article, after being removed from the oven, is now ready for receiving the touches necessary to place it among antique goods. What this involves depends on circumstances. The metal work is soon tarnished by exposure to dampness, and the wood work rapidly collects dust. There is no doubt that reproductions of rare pieces of antique furniture can be honestly made and sold just as copies of favorite oil paintings are reproduced and sold. The dishonesty is when the dealer tries to sell the reproduction as an original.

ROMAN ROADS AND MILESTONES IN ASIA MINOR.

A military power such as Rome was could not long be content with the bridle paths which all primitive peoples find sufficient to subserve their commercial interests. For, in order to facilitate the shifting and concentration of their armies at strategic points, they needed a better and more comfortable means of rapid transit than was furnished by the primitive bridle path. The primary object which the Roman international roads were intended to subserve was military in character, and therefore they were known as viæ militares, though in the provinces we find viæ consulares and viæ prætoriæ, because they were built by proconsuls or proprætors respectively.

The width of the Roman road varied much according to its importance. Often it was 120 feet wide, though in the provinces it was generally 60, sometimes 40 feet wide. In order to understand the reason for this great width and for the substantial construction that was rigidly adhered to, we should bear in mind the make-up of the Roman army, whose comfort and necessities were continually consulted. In the first place, the Roman soldier was burdened by his heavy armor and other impedimenta in such a manner as to render him wholly unfit (impeditus) to repel sudden attack successfully, as we read on nearly every page of Cæsar's Commentaries. The baggage train was far larger and more unwieldy than anything we know of to-day for the reason that this train had to transport not merely the tents, artillery, arms, munitions of war, army chest, and a host of other things necessary in the warfare of that day; not merely the effects and plunder of the legionaries, but also those of two secondary armies—an army of women, wives of the legionaries and camp-following prostitutes, and another army of body servants, for each legionary had one or more servants, so that the calones outnumbered the legionaries themselves. When on the march, this unwieldy army maintained the line-of-battle order, theoretically at least, in order to be ready to repel sudden and unexpected attack. Good roads, therefore, were necessary in order to enable the immense train with which the army was handicapped to keep pace with the legionaries, and wide roads were essential, in order, in case of sudden attack, to allow the individual legionaries to make effective use of their arms without interfering with their neighbors.

The Roman roads were built with more care than is expended upon the beds of our railways even. They were made as straight as possible, and natural obstacles were skillfully overcome by the use of cuts, fills, bridges, culverts, embankments, and even tunnels. Stiff grades were avoided, and a level, once reached, was doggedly maintained, even at the expense of making cuts, fills, etc. The work preliminary to the building of any Roman road consisted in excavating all the dirt down to hardpan, and the excavation thus made was filled in, regardless of expense, with layers of sand, stone, and cement, until the requisite level, however high it might be, had been reached. Finally, the surface was dressed with a layer of metal and cement. The road was practically indestructible, and required only occasional repairs. That continuous or even merely yearly repairs were not necessary seems clear from the fact that, when repairs were made, the proprætor of the province thought it so important an event that he celebrated it by inscribing the fact along with his name on the milestones.

Many years ago Bervier made an examination of certain Roman roads still in France. One road was examined at a point where it had been raised 20 feet above the level of the surrounding country, and a vertical section revealed a structure of five layers. First came the great fill of 16½ feet; on the top of this fill came, first, a foot layer of flattish stones mixed with cement, then a foot layer of flattish stones without cement, then a foot layer of firmly packed dirt, then a

half-foot layer of small metal in hard cement, and lastly, a half-foot layer of large metal and cement. Other roads investigated by Bergier, while differing in treatment, were just as substantial roads. Paved roads were rare, but the Via Appia offers a remarkable instance of a paved road. The stone used in its pavement is of the kind of which millstones are made, and they are so carefully dressed and adjusted that the road often seems to be solid rock, and has proved so indestructible that, after two thousand years of continuous use, it is still a superb road. In the countless inscriptions which state that such and such a governor under such and such an emperor repaired the roads and bridges in his province, reference is made to the top dressing of metal and cement. The military road of the provinces was usually 60 feet wide, and was divided into three tracks, a raised center and two side tracks, each track being 20 feet wide.

If the old Roman roads in Italy, France, and elsewhere are still existent and in use, there is an especial reason therefor, quite apart from the fact that these roads were originally built for eternity. In the days of Rome's ascendency all roads led to Rome, and in Europe this has never ceased to be more or less a fact. No city of Europe ever attained such transcendent importance as to make necessary a complete change in the general direction of the road system; so that, in spite of the decline of Rome and the rise of other centers, the roads of Europe still lead to Rome.

In Asia Minor the case was different. Before written history opens, the great emporium of Asia Minor was Pteria, the capital city of the great Asiatic peninsula. The prehistoric system of roads led to Pteria; one great artery was the road from Pteria (or later on, Tavium) to Ephesus on the seaboard; a second was the road from Pteria-Tavium through the Cilician Gates to the southern seaboard, etc. Later on, when the Persians gained control over Asia Minor, Pteria had ceased to exist, but its neighboring Tavium rose in importance and became the emporium of all central Asia Minor. Roads led to Tavium. The first artificial trade roads (leaving out of consideration the mythical roads of Semiramis) were, therefore, built by the predecessors of the Persians in Asia Minor. The first road mentioned in written history was the Royal Road which led from Ephesus to Susa. Now this Royal Road was nothing in the world but the old Hittite road (or roads) along whose immense zigzag the Persians were content to jog for centuries, never dreaming, apparently, of a short cut. If the Persians had built the road themselves, they would never have been guilty of the incomprehensible folly of making the great détour from the Cilician Gates via Tavium to Ephesus, instead of following the direct and natural trade route from the Cilician Gates via Iconium, Antiochia, Calænæ, and the Lycus Valley to Ephesus. The Greek kings and their successors, the Romans, adopted this natural shortcut, and the Royal Road lapsed into desuetude. Then all roads led to Ephesus, because Ephesus was the gateway to Rome. Later on, Constantinople arose and disputed the queenship with Rome. Her rise demanded a thoroughgoing change in the general direction of all roads in Asia Minor. Roads no longer led to Rome—that is, to Ephesus—but to Constantinople. The Roman road system in Asia became useless for purposes of trade, and was degraded first to neighborhood roads; and as for fifteen hundred years the roads have continued to lead to Constantinople, the good old Roman roads were finally abandoned, lost, and forgotten. Occasionally the traveler can locate a section of a Roman road (though their course must generally be argued from the milestones, as will appear presently). One such at Kiakhta in distant Kommagene is now a silent but eloquent reminder of Rome's solicitude for even her most distant provinces; every stone of the magnificent old bridge on this road tells a pathetic story of the passing of human grandeur.

For Italia, distances were measured from the milliarium aureum in Rome; from Milan for Gallia Cisalpina; from Lyons and Rheims for Gallia Celtica and Belgica respectively, etc. So, in Asia, distances were measured from the provincial centers, from Tavium for Cappadocia; from Melitene for Armenia; from Palmyra for Palmyrene, etc.

Tavium, in northwestern Cappadocia, was, as we have seen, a city of importance at the very beginning of history, and continued to be a center of commerce down possibly to early Byzantine times. The celebrated rock sculptures of the neighboring Boghazkieni (Pteria) and Eyuk prove that Tavium was inhabited by the people nowadays called the Hittites, who have left enduring memorials of their high civilization in the rock sculptures found throughout Asia Minor and northern Syria. After the fall of the Hittite empire, Tavium continued to flourish under the Persians, and was an important station on the Royal Road, over which the earliest recorded postal service traveled. It was the center of the Roman road system for the whole of northwestern Cappadocia, Pontus, and Galatia, being the point from which radiated no less than seven Roman roads. Consequently, it is a matter of the highest importance for ancient geography that the site of Tavium be located with absolute certainty. An elaborate postal service was kept up throughout the Roman empire; several precious lists of postal stations have come down to us (e. g., the Antonine itinerary, among others). These lists give not only the names of the postal stations, but also the distance from station to station in Roman miles, beginning with a certain city as the point from which distances were measured for the whole surrounding country for at least two hundred miles. Just as at Rome the milliarium aureum was the official spot from which distances were measured, so central milliaria were erected in Asia Minor in the cities from which distances were measured along the roads of a given province. Many of these starting-points are given in the Itineraries, or in the Peutinger Table—an ancient map that chance has preserved: but many of the starting-points are not given, and, therefore, it behooves the traveling archæologist to hunt up the Roman milestones that may have survived to the present day, in order to read from them the story they have to tell in regard to the Roman road system.

If the starting-point be once fixed, then the location of the cities or postal stations between, say, Tavium and Ancyra is a comparatively easy matter, that requires only patient investigation of the region of country on the line of march between Tavium and Ancyra. Thus, at a distance of, let us say, twenty Roman miles, as one travels west from Tavium, the traveler knows that he must find the ruins of a town or postal station, and so he scours the country until he finds the object of his search. In many cases the stations were so insignificant that no remains of them will have been spared to the present day, especially if they were mere temporary quarters, consisting of buildings for the care of relays of horses and the entertainment of the officials in charge. It matters little if the traveler find no traces of these insignificant intermediate stations, provided the mileage between two fixed points, such as Tavium and Ancyra, be ascertained to be beyond all doubt. In that case it is only necessary for the traveler to measure off the distances of the Itinerary, and he has the whole line fixed with a very near approach to certainty. However, if he succeeds in finding one or more of the intervening stations, that fact will strengthen his case materially. Now, from the time when geographers first began to make maps of Asia Minor, they have sorely needed a certain identification of the site of Tavium, and in 1884 it fell to my lot to discover the first milestone on the Roman road between Tavium and Ancyra. This milestone, therefore, locates Tavium definitely, and enables the geographer to fill in with comparative ease the map of the country reaching west to Ancyra, and east to Cæsarea, Sebastia, Amisus, Amasia, etc. Afterward I found the hundredth milestone on the same line, a fact which proved that I was following along the Roman road. In default of this direct epigraphical evidence, a clear case of the corruption of the ancient name by the Turks is a most safe way of identification. For instance, after leaving Tavium I traveled northward, following the line of the ancient Roman road as laid down in the Peutinger Table, and at Tamba Hassan I found several badly defaced Roman milestones, a fact which proved that I was locating the road correctly. Now the Peutinger Table gives Tamba as the first station on this road at a distance of thirteen Roman miles from Tavium, and it takes very little acumen to discover the Tamba of the Peutinger Table in the Turkish Tamba Hassan.

Milestones were erected along the entire line of the Roman military roads. I can speak from personal observation only of those of Asia Minor and Syria. In shape they are a conical column, round in horizontal section, and monolithic. They vary from seven to nine feet in height, with a diameter at the base of from two and a half to four feet, but tapering off to a foot and a half at the bluntly rounded top. They are merely rough dressed. The majority of them bear inscriptions, which are usually in Latin, but sometimes in Greek, sometimes in both Latin and Greek, while sometimes the distance alone is given in both Latin and Greek. The distance is usually unaccompanied by a statement as to the place from which the distance was measured, though sometimes both the starting-point and the objective point are given. The inscriptions on these milestones give not only the name of the Emperor during whose reign the road was constructed or repaired, but what is of great importance for the history of the region, also the name of the Roman governor during whose term of office the road was constructed or repaired. I found in all about one hundred inscribed milestones, many of which were inscribed two and even three times. When the Roman road was originally built, milestones, bearing inscriptions dated by the name of the then reigning Emperor and that of the proprætor who constructed the road, were erected at every mile. Now in the course of time the road needed repairs. A new Emperor was wearing the purple in Rome. A new governor, who cared naught for the works and the honor of his predecessors, was lording it in the province. This new governor was forced to repair the roads and bridges in his province, but instead of going to the expense of erecting new milestones bearing inscriptions announcing his work, he simply had his inscriptions cut on the old stone and directly over the old inscription without having first erased it. Of course while the marks of the chisel were fresh and unweathered the new inscription might be read with comparative ease; but as soon as time and weather had dimmed the freshness of the more recent inscription, then it became a matter of science to decipher the twain. It sometimes happened that a third inscription was cut over the already existing two. I found several such, and my despair when brought face to face with such a stone may be imagined. However, the decipherment proved to be merely a matter of persevering study and painstaking combination of details. Most of these milestones were found in Cataonia, the region east of the Anti-Taurus range of mountains. At the time I was traveling eastward toward the Euphrates from Comana (the Golden), once the seat of the worship of the great Asiatic goddess of fecundity (here known as Ma) in whose temple no less than six thousand slaves (mostly women) were kept; whose chief priest was next in rank to the King of Cappadocia. Judging, then, from the importance of Comana, one might naturally suppose that it was the starting-point of the system of Roman roads for the trans-Anti-Tauran region. But about two hours east of Comana I found the 144th milestone. This, then, was proof positive that Comana was not the starting-point. As I continued to journey eastward and to discover new milestones, I found that the numerals on the stones steadily decreased, until finally it became certain that Melitene (now Malatia), not far from the Euphrates, was the starting-point of which I was in quest.

After my explorations in Cataonia (or Armenia Minor), where I came daily into contact with the Roman milestone, I joined the Wolfe expedition to Assyria and Babylonia. On the home journey from Babylon and Bagdad, we crossed the Syrian desert. About one day's journey east of Palmyra, and while still in the desert, my eyes suddenly fell upon a large stone lying by the roadside. It was a Roman milestone, but uninscribed. However, it served to put me on the alert. Further on another and still another uninscribed milestone was found, until finally I had the satisfaction of finding an inscribed stone, the eighth on the Roman road from Palmyra to Aracha, showing that distance was reckoned from Palmyra. It is well known that people, manners, customs, and names of places change very slowly in the conservative East—nay, the life of Abraham, Isaac, and Jacob may be seen throughout the Mesopotamia and Chaldea of to-day; and many of the cities whose names were familiar to the patriarchs of the Bible still bear their Biblical names. Of this intense stability both of the names on this 8th milestone are interesting examples. Palmyra is but the Latin translation of the Semitic Tedmur, the place of the palms, and its name is still Tedmur, and nothing but Tedmur, throughout the Orient of to-day. Aracha, the other name mentioned in the inscription on this milestone, is the Latinized form of the Semitic name Erek, and this Erek is still existent, and still bears the name Erek. It is the first station as one journeys east from Palmyra.

Leaving this 8th milestone, we journeyed on toward Palmyra, finding nearly all of the remaining seven milestones, some of them being still in position. West of Palmyra we found the Roman road leading from Palmyra to Hama, and followed it for about five miles, finding inscribed stones, all still erect and in position. If we did not know the exact length of the Roman mile from other sources, it might be measured from the stones of this road. I say road, but it is no longer a road. We were traveling over the desert without any road, being guided by native Palmyrenes who knew where the water puddles were to be found in the spring of the year. We stumbled by the merest accident upon a milestone, and shortly afterward another one was descried in the distance. Thus we got the direction of the road and followed it for a few miles—as long, indeed, as prudence would allow; and we turned away from the road and the milestones in silence and in sorrow. Some future traveler who has the courage and the means to venture over the trackless waste between Palmyra and Hama will reap a rich epigraphical harvest.

There is something awe-inspiring about these hoary guardians of the Roman road, simple and rough-hewn though they be. Like the Roman sentinel of old, they are still true to their trust, eloquent and stately reminders of the mighty deeds of mighty Rome. Fourteen, fifteen, hundred years have swept over them; they have witnessed the prolonged death-struggle of the imperial city of the seven hills; they have seen empires, nations, arise and grow wanton in the pride of strength, only to return to the nothingness from which they sprang, but they still stand proudly erect, simple, austere, sublime, in the silence and the solitude of the desert, bidding defiance to time and to man. —J. R. S. Sterrett, in The Nation.

THE INTERNATIONAL CLOUD WORK OF THE WEATHER BUREAU.

By FRANK H. BIGELOW, Professor of Meteorology, U. S. Weather Bureau.

IN the month of May, 1896, several national meteorological services began in co-operation to take a series of simultaneous observations on the height and the motion of the ten standard types of clouds which have been defined by the International Committee. The object of this survey of the movements of the atmosphere, continued for at least one year, was to gather material that could be used to determine the action of the higher strata with reference to the formation and the progressive motion of storms. Our observations are generally so exclusively made in the lowest level of the ocean of air that comparatively imperfect information exists regarding the higher currents upon which to found intelligent theories, and it is with the purpose of supplying this deficiency that the series of international observations was undertaken. By the liberal policy of the United States government, the Weather Bureau was able to do its part of this work. The discussion of the data is now nearly finished for the report which it is expected to issue before the end of the present year. While it is not practicable to give any detailed account of the results, it may be interesting to have presented in The National Geographic Magazine a brief synopsis of the scope of the report now being prepared by the writer.

The observations are divided into two classes: (1) The primary, which are made by means of two theodolites placed at the end of a long base line adapted to triangulations in the vertical direction. These give the absolute heights, velocities, and direction of motion of individual clouds; between 6,000 and 7,000 of such observations were made at Washington, D. C. (2) The secondary, executed with nephoscopes at fourteen stations distributed at nearly equal distances from each other over the districts east of the Rocky Mountains, give the relative velocities and direction of motion, and with the help of the results obtained by the primary system can be translated into absolute values; there were 25,000 to 30,000 of these observations made in the United States.

The discussion of these data has been divided into a number of parts, of which the following may be mentioned in this connection: (1) The distribution of the cirrus, cirro-stratus, cirro-cumulus, alto-cumulus, alto-stratus, strato-cumulus, cumulo-nimbus, nimbus, cumulus, stratus, was so determined that we now know the average height of each type for every month in the year and the depth of the zone or horizontal belt in which they may severally occur. Thus the upper types are found in layers as much as six miles thick, though they form most frequently near the middle of their respective belts; the lower are thinner, and have some peculiar characteristics besides. When we consider that the height and shape of these belts, changing from month to month, indicates some very delicate physical process going on in the aqueous vapor of the atmosphere, it is easy to see that they become the best means for studying the state of the pressure, temperature, and vapor tension—that is, the physics of the air itself. (2) A very important subject has been the determination of the direction and velocities of the horizontal motions of the air in each of the eight principal levels, on all sides of the anti-cyclones and cyclones, high and low areas of pressure, as they move over this country. These movements have been separated into two components, the first belonging to the general or undisturbed motion of the atmosphere, which is about eastward in this latitude, and the second to the local motions, which are gyratory and especially concerned with descending and ascending vortices or storms. These data give us for the first time definite information regarding storm components, and these enable us to look into the theories much more closely than heretofore. (3) This analysis has been supplemented by a compilation

of cloud motions taking place in the cumulus or the cirrus levels, as derived from the Weather Bureau cloud charts collected during the past twenty years, the object of which is to show how the average anticyclone and cyclone are affected by the circulation of the air over different parts of the United States—that is, by the Rocky mountains, the Lake Region, the Gulf of Mexico, and the Atlantic States—the results being exhibited on a series of colored charts.

These practical facts lead to the necessity of definite theoretical studies in order to account for them, and this again to several other lines of research: (1) The first thing was to prepare a system of standard constants and formulæ by a comparative study of the papers of several authors, and by the addition of such new demonstrations as seemed desirable, so that the work of many men in their several branches may be read as one consistent meteorological scheme. This standard system represents the outcome of several years' study of the subject. These formulæ include most of the thermodynamic or hydrodynamic conditions likely to arise on a rotating body surrounded by an atmosphere, like the earth. (2) Next, a completely new set of working tables, based upon these formulæ, has been prepared for the barometric reductions from one level to another; for studying with the greatest accuracy the exact conditions of pressure, temperature and vapor tension at the level where a cumulus cloud base forms by the vertical convection, at the place where the hail forms, and at the level where the snow is produced; and finally for computing the dynamic forces and the gradients of motion according to the observed velocities. These tables are permanently useful to meteorology, and that they are needed is seen from the following considerations: The Smithsonian tables and the International tables are adapted for the reduction from elevations 2,000 meters or less to the sea-level; but in cloud work it is necessary to reduce at will throughout a region up to 15,000 meters in height and with ranges of temperature from + 30° to −60° Centigrade, which is far beyond limits of any existing tables. The Hertz diagram for adiabatic expansion leaves out the vapor contents of the air in parts of the formulæ, introducing errors as much as 0·30 inch in pressure. Besides, it is desirable to be able to start with surface conditions and compute upward in exact figures all the elements existing in the cloud, and also the gradients connecting one level with another.

Since the atmosphere differs very widely from the adiabatic laws, one of our problems is to discuss how much this departure is for all seasons of the year, and from these data we expect to study carefully the laws of solar insolation and terrestrial radiation—that is, the actinometry of the atmosphere—by means of this new and improved material. Finally, there are no tables published which are available for computing the dynamic forces indicated by the equations, and this is necessary if meteorology is to be made an exact science. (3) The possession of all this new matter enables us to analyze closely the Ferrel theory of the local cyclone and the German theory of the same, which differ from each other, and to show that they are both only ideal solutions of vortices and do not conform to the stream lines given by the observations. An attempt has been made to interpret the analytical equations of motion, so that they shall match the observed facts, and this leads to a different idea of the circulation in storms from that commonly taught by meteorologists. The application of the theory to tornadoes is certainly satisfactory, and in the case of hurricanes and cyclones it is on the whole very promising.

BRIGHTNESS OF WHITE SURFACES.

In the Ann. d. Physique und Chemie, 1898, p. 1182, P. Jenks compares a piece of white paper, when lighted, with the brightness of a meter candle (about 0·1 foot-candle), and finds that the brightness of a candle is 12,000 to 22,000 times, and the Violle unit 1,008,200 times as great as the paper. Comparing the brightness of various surfaces when lighted by the same light source, he finds the ratio to be as follows:

Bristol board	1·000
Photometer paper	0·698
Freshly fallen snow	1·05 to 1·11
Zinc oxide, with 5 per cent. gypsum	1·169
White lead	1·207
Magnesium carbonate	1·29

The last gives a matt surface which is equally brilliant at all illumination angles.

The finest pineapple cloth comes from the Philippines, but very good tissues are turned out wherever there are Malays, and of late years by Mongolians and other communities. The thread is obtained from the pineapple leaves in some curious way which separates the fine filament from all the other vegetable tissues. It is then partially dried and bleached in the sun, and is then carded and spun. After its spinning, and before it is thoroughly dry, it is woven on the old fashioned looms which are busy to-day in Asia. The technical skill possessed by the spinners and weavers is truly admirable. Men are too clumsy for the work and women have a practical monopoly of it, but even among them there are many whose eyes and fingers are not quite delicate enough to distinguish between the thickness of one thread and another. The weaving is done within doors and usually in a Malay house, whose bamboo framework, walls made of leaves and heavy thatched roof, keep the interior quite dusky and damp. When produced the cloth is plain in color or else made according to an order, or according to Malay tastes. The finest quality of cloth is so fine as to be practically translucent, and some tissues which were worth more than their weight in silver would stand successfully the test of the Indian rajah who would accept no cloth unless he could draw the whole roll through his signet ring.

Mining in Spain is heavily burdened. There is an annual royalty of 15 pesetas on minerals, a duty of 3 per cent. on the gross values of all ores extracted, an exportation tax, so much per ton on all ore shipped from Spanish ports, port dues, duty on explosives used in mines, an industrial tax on all mining apparatus, a stamp duty on each page of the required set of books used by mining companies, a 12 per cent. duty on the profits of railway transportation of ore, etc.

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